

AADvance

The Next Step in Automation

AADvance Controller System Build Manual

ICSTT-RM448I-EN-P

May 2015

LISTEN.
THINK.
SOLVE.*

 Allen-Bradley • Rockwell Software

**Rockwell
Automation**

Page intentionally left blank.

LISTEN.
THINK.
SOLVE.*

 Allen-Bradley • Rockwell Software

**Rockwell
Automation**

PREFACE

In no event will Rockwell Automation be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment. The examples given in this manual are included solely for illustrative purposes. Because of the many variables and requirements related to any particular installation, Rockwell Automation does not assume responsibility or reliability for actual use based on the examples and diagrams.

No patent liability is assumed by Rockwell Automation, with respect to use of information, circuits, equipment, or software described in this manual.

All trademarks are acknowledged.

DISCLAIMER

It is not intended that the information in this publication covers every possible detail about the construction, operation, or maintenance of a control system installation. You should also refer to your own local (or supplied) system safety manual, installation and operator/maintenance manuals.

REVISION AND UPDATING POLICY

This document is based on information available at the time of its publication. The document contents are subject to change from time to time. The latest versions of the manuals are available at the Rockwell Automation Literature Library under "Product Information" information "Critical Process Control & Safety Systems".

DOWNLOADS

The product compatibility and download center is
www.rockwellautomation.com/rockwellautomation/support/pcdc.page?

Select the Find Downloads option under Download
In the Product Search field enter "AADvance" and the AADvance option is displayed.
Double click on the AADvance option and the latest version is shown.
Select the latest version and download the latest version.

AADVANCE RELEASE

This technical manual applies to **AADVANCE Release: 1.34**

LATEST PRODUCT INFORMATION

For the latest information about this product review the Product Notifications and Technical Notes issued by technical support. Product Notifications and product support are available at the Rockwell Automation Support Center at
<http://rockwellautomation.custhelp.com>

At the Search Knowledgebase tab select the option "By Product" then scroll down and select the ICS Triplex product AADvance.

Some of the Answer ID's in the Knowledge Base require a TechConnect Support Contract. For more information about TechConnect Support Contract Access Level and Features please click on the following link:

https://rockwellautomation.custhelp.com/app/answers/detail/a_id/50871

This will get you to the login page where you must enter your login details.

IMPORTANT A login is required to access the link. If you do not have an account then you can create one using the "Sign Up" link at the top right of the web page.

DOCUMENT NUMBER

The UK document number: 553632

© Copyright Rockwell Automation 2015.

DOCUMENTATION FEEDBACK

Your comments help us to write better user documentation. If you discover an error, or have a suggestion on how to make this publication better, send your comment to our technical support group at
<http://rockwellautomation.custhelp.com>

SYMBOLS

In this manual we will use these notices to tell you about safety considerations.

SHOCK HAZARD: Identifies an electrical shock hazard. If a warning label is fitted, it can be on or inside the equipment.



WARNING: Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which can cause injury or death, property damage or economic loss.



ATTENTION: Identifies information about practices or circumstances that can cause injury or death.



CAUTION: Identifies information about practices or circumstances that can cause property damage or economic loss.



BURN HAZARD: Identifies where a surface can reach dangerous temperatures. If a warning label is fitted, it can be on or inside the equipment.



This symbol identifies items which must be thought about and put in place when designing and assembling an AAdvance controller for use in a Safety Instrumented Function (SIF). It appears extensively in the AAdvance Safety Manual.

IMPORTANT

Identifies information that is critical for successful application and understanding of the product.

NOTE

Provides key information about the product or service.

TIP

Tips give helpful information about using or setting up the equipment.

WARNINGS AND CAUTIONS

WARNING: EXPLOSION RISK



Do not connect or disconnect equipment while the circuit is live or unless the area is known to be free of ignitable concentrations or equivalent

AVERTISSEMENT - RISQUE D'EXPLOSION



Ne pas connecter ou déconnecter l'équipement alors qu'il est sous tension, sauf si l'environnement est exempt de concentrations inflammables ou équivalente

MAINTENANCE



Maintenance must be carried out only by qualified personnel. Failure to follow these instructions may result in personal injury.

CAUTION: RADIO FREQUENCY INTERFERENCE



Most electronic equipment is influenced by Radio Frequency Interference. Caution should be exercised with regard to the use of portable communications equipment around such equipment. Signs should be posted in the vicinity of the equipment cautioning against the use of portable communications equipment.

CAUTION:



The module PCBs contains static sensitive components. Static handling precautions must be observed. DO NOT touch exposed connector pins or attempt to dismantle a module.

ISSUE RECORD

Issue	Date	Comments
01	April 2008	First Issue
02	Feb 2009	Update for Product Titles
03	Nov 2009	Update for Release 1.1
04	July 2010	Update for Release 1.1.1
05	Oct 2010	Updates for UL Certification
06	March 2011	Updated for Release 1.2
07	Aug 2011	Updated for UL Requirements
08	July 2012	Updates for release 1.3 and 1.31
09	May 2014	Updates for UL ATEX/IECEx Certification and T9892 information.
10	March 2015	Updates for Release 1.34.
11	May 2015	Correct Documentation Feedback URL and Issue Record

Page intentionally left blank.

Table of Contents

PREFACE	Chapter 1
The AAdvance System	Chapter 2
The AAdvance Safety Controller	Safety Features 17 Safety Configurations 18 Safety System Certification 19 Performance and Electrical Specifications 19 Scan Times 20 System Installation Environment 22 Environment Standards 23 Installation Requirements for Non-Hazardous Environment 23 Installation Requirements for Hazardous Environment 24 Certifications for Safety System Applications in Hazardous Environments 26 Module Label 37 KCC-EMC Registration 37 The AAdvance Workbench and Software Development Environment 37 Operating Systems (32 or 64 bit) 39 Importing and Exporting Data 40 AAdvance Workbench Licensing 40 Corrective Maintenance and Module Replacement 40 TUV Approved Operating System 41 Main Components 41 Physical Features 41 Environmental Specification 42 Product Dimensions 44 Compact Module Design 45 Module Polarization Keying 46 Module Locking Mechanism 47 Field Wiring 47 Processor Base Unit 49 External Ethernet, Serial Data and Power Connections 49 Serial Communications Ports 50 Processor Back-up Battery 51 Processor Maintenance Socket 53 I/O Base Unit 54 Termination Assemblies 54 Backplane Electrical Ratings 57 Expansion Cable 59 Technical Features 59 Controller Internal Bus Structure 59 Internal Diagnostics and Fault Reset 60 Remote Fault Reset 61 On-line updates I/O Configuration Changes 61 Hot Swap I/O for Business Critical Channels 62

Processor Firmware Upgrades	62
Ethernet Communication Protocols	63

Chapter 3

Application (Resource) Development

Programming Language Support.....	65
Program Management Facilities.....	65
Support for Variable Types	65
I/O Connection (Addressing of Physical I/O)	66
Off-line Simulation and Testing	66
Application (Resource) Program Security	67
Aids to Software Development.....	67

Chapter 4

Before You Begin

Required Tools Standard AADvance	69
Specifying an Enclosure	70
Maximum Enclosure Air temperature	70
Enclosure Requirements for a Non-hazardous Environment... 71	71
Enclosure Requirements for a Hazardous Environment - Class I, Division 2, Groups A, B, C and D.....	71
Controller Mounting	74
Free Space around the Controller	74
Base Units Rows and Expansion Cables	77
Adding Field Cable Management	78
System Power Requirements	79
Power Supply and Power Distribution Requirements	80
Controller Power Supply Requirements	80
Power Arrangements for Field Devices	81
Estimating Power Consumption	82
System Design Considerations for Heat Dissipation and Cooling 83	83
Estimate Heat Dissipation.....	83
Estimate AADvance Controller Weight	85
Estimating Center of Gravity Information	85
Design Considerations for Electrical Grounding.....	85
Specifying the Workstation PC.....	86
Design Considerations for Maintenance Activities	87
Connecting the AADvance Controller to the Network.....	89

Chapter 5

Install the AADvance System

Unpacking and Pre-assembly Checks	91
Install Base Units and Termination Assemblies: Enclosure DIN	
Rail Assembly Method.....	92
Allocations of Coding Pegs	95
Install Base Units and Termination Assemblies: Flat Panel	
Assembly.....	96
Allocations of Coding Pegs	98
Connect the AC Safety Ground Connection.....	99
Connect the 24 V dc System Power to an AADvance Controller	100
Procedure to Connect Serial Communications Cabling.....	101
Connecting Modbus Slave Devices to Serial Ports.....	102
Connect a Slave Device, Full Duplex	103
Connect Multiple Slave Devices, Full Duplex	104
Connect a Slave Device, Half Duplex	105
Connect Multiple Slave Devices, Half Duplex.....	106
System Security	107
Connecting Field Wiring.....	108
Digital Input Field Loop Circuits.....	108
Analogue Input Field loop Circuits.....	112
Recommended Field Circuit for Digital Outputs.....	116
Recommended Circuit for Analogue Outputs.....	119
Install Modules.....	121
Install a 9110 Processor Module.....	121
Replace a Faulty Processor Back-up Battery	122
Set the Real Time Clock Manually	125
Install I/O Modules	127
Install T9310 Expansion Cables	128
Fault Reporting Reference Information	131
Status Indicators on the 94xx Series Input and Output	
Module	131
Status Indicators on the 9110 Processor Module.....	132

Chapter 6

System Start-Up

Recommendations to Manage Test Documentation.....	135
System Physical Design Check	135
Procedure to Verify Build State	136
Procedure to Conduct the Mechanical Inspection	136
Procedure to Check Ground Bonding	136
Procedure to Check Power Distribution Integrity.....	137
Power Distribution and First Power Up.....	137
Start Up Process	138
Processor Module Start Up Process.....	139
I/O Module Start-up Process.....	142

Processor Firmware Upgrades	143
Stage 1: Install ControlFLASH for Recovery Mode and Secondary Boot Firmware	144
Upgrade the Processor Module Recovery Mode Firmware.....	147
Stage 2: Install ControlFLASH for System Firmware.....	153
Upgrade Processor OS, FPGA, LSP and BUPF Firmware.....	153
Setting the Controller IP Address for AADvance Workbench Communications	158
Controller IP Address	158
Troubleshooting AADvanceDiscover Communications	159
Configure the Controller Resource Number in the Controller.....	159
Configure the IP Address in the Controller	162

Chapter 7

Functional Acceptance Testing

Devising tests for Functional Acceptance	165
Test Environment for Functional Acceptance.....	165
Managing Functional Acceptance Testing	166

Chapter 8

Dismantling the AADvance System

About Dismantling a System.....	167
---------------------------------	-----

Chapter 9

Parts List

Chapter 10

9000 Series Glossary

Glossary of Terms	173
-------------------------	-----

Chapter 11

Additional Resources

Regional Offices.....	187
-----------------------	-----

The AADvance System

An AADvance system consists of an AADvance controller, an external operator's workstation, field connections, power sources and external network connections. The flexibility of the design means that a system can meet a wide variety of business needs. An AADvance system is assembled to a scale and configuration that is applicable to your initial requirements and can be easily changed to meet your changing business requirements in the future. A system is built from an approved range of modules and assemblies.

This chapter introduces the primary components that can be used to assemble an AADvance controller.

Page intentionally left blank.

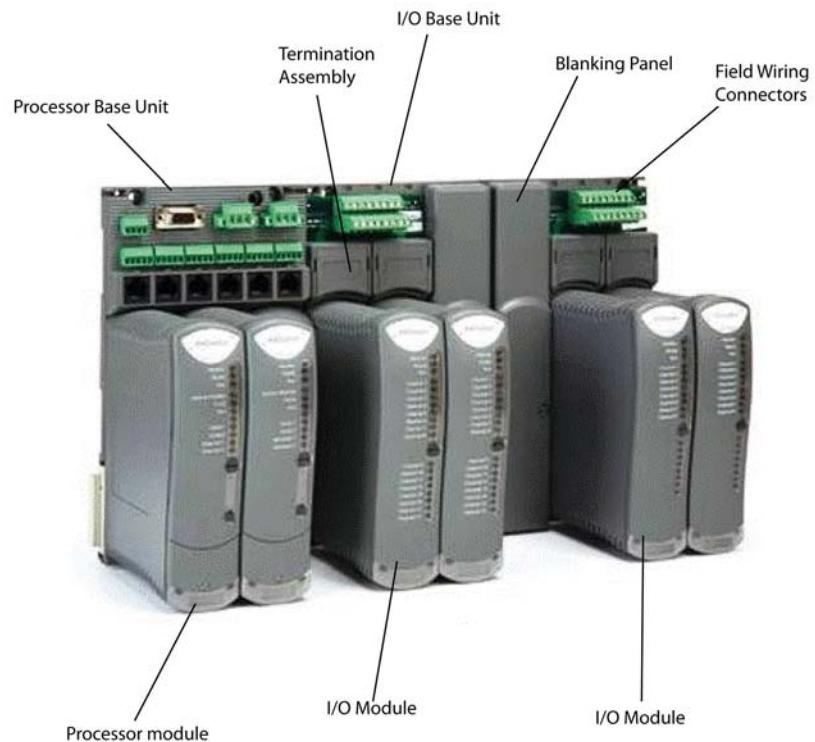
The AADvance Safety Controller

The AADvance controller is specifically designed for functional safety and critical control applications; it gives a flexible solution for smaller scale requirements. The system can also be used for safety implemented functions as well as applications that are not related to safety but are nevertheless critical to a business process. This AADvance controller offers the ability to make a cost-effective system to a customer's specification for any of the following applications:

- Emergency shutdown system
- Fire and gas installation protection system
- Critical process control
- Burner management
- Boiler and furnace control
- Distributed process monitoring and control
- Turbo-machinery governor control and over-speed protection (not yet released)

An AADvance controller is particularly useful for emergency shut down and fire and gas detection protection applications as it offers a system solution with integrated and distributed fault tolerance. It is designed and validated to international standards and is certified by TÜV for functional safety control installations and UL for use in hazardous environments.

A controller is built from a range of compact plug-in modules (see illustration) that are straightforward to assemble into a system. A system can have just one or more controllers, a combination of I/O modules, power sources, communications networks and user workstations. It can operate as a stand-alone system or as a distributed node of a larger control system.



NOTE

The printed circuit boards of all AADvance modules, termination assemblies and backplanes are coated during manufacture. The coating meets defense and aerospace requirements, is approved to US MIL-1-46058C standard and meets IPC-CC-830. The coating is also UL approved.

A Key benefit of the AADvance system is its flexibility. All of the configurations are readily achieved by combining modules and assemblies without using special cables or interface units. System architectures are user configurable and can be changed without major system modifications. Processor and I/O redundancy is configurable so you can make a decision between fail safe and fault tolerant solutions. There is no change to the complexity of operations or programming that the controller can handle if you add redundant capacity to create a fault tolerant solution.

They can be mounted onto DIN rails in a cabinet or directly mounted onto a wall in a control room. Forced air cooling or special environmental control equipment is not necessary. However, important consideration must be given to the choice of cabinet or when the controller is installed in a hazardous environment.

Specific guidelines are given in this user documentation to help you choose an enclosure that will make sure that the system operates to its

full capability and reliability and that it also complies with the ATEX and UL certification requirements for use in hazardous environments.

The Ethernet and serial ports are configurable for a number of protocols in both simplex and redundant configurations for connection to other AAdvance controllers or external third party equipment.

Communications internally between the processors and I/O modules uses a proprietary communications protocol over a custom wired harness. The AAdvance system supports transport layer communication protocols such as TCP and UDP for Modbus, CIP, IXL, Telnet and SNTP services.

A secure network communications protocol (SNCP), developed by Rockwell Automation for the AAdvance system, permits distributed control and safety using new or existing network infrastructure while ensuring the security and integrity of the data. Individual sensors and actuators can connect to a local controller, minimizing the lengths of dedicated field cabling. There is no need for a large central equipment room; rather, the complete distributed system can be administered from one or more PC workstations placed at convenient locations.

The AAdvance controller is developed and built for IEC 61131 compliance and includes support for all five programming languages. (Instruction List (IL) and Sequential Function Chart (SFC) languages are not supported by AAdvance Workbench 2.0). Program access is secured by a "Program Enable" key that you can remove. Simulation software lets you prove a new application before reprogramming and downloading, again maximizing system uptime. Additional security functions are also included to prevent unauthorized access.

Safety Features

The AAdvance controller meets non-safety business requirements and SIL 2 and SIL 3 safety related system requirements. The system has comprehensive built-in redundant capabilities that improve system availability.

The AAdvance safety system features are:

- Easily transformed from a simplex non-safety system to a fault tolerant safety related system.
- An AAdvance platform provides a set of components that can be configured to meet a range of safety and fault tolerance user requirements within a single system such as - fault tolerant topologies 1oo1, 1oo2D and 2oo3.
- IEC 61508 certified, reviewed and approved for safety systems up to SIL 3 by TÜV.
- The scalable characteristics of the system enables independent safety functions within the same system to be configured with

different architectures to meet a user specific safety and availability requirements.

- The main components that provide the safety architecture are the processor and I/O modules; the remaining components provide secure external interfaces and connectivity between the field elements and the main components and add to the safety functionality.
- AADvance processor modules are designed to meet the requirements for SIL 2 in a simplex configuration and SIL 3 in a dual or triplicated configuration.
- Individual input modules are designed to meet the requirements for SIL 3 in simplex, dual or triple configurations.
- Individual output modules have been designed to meet the requirements for SIL 3 in a simplex or dual configurations.
- Safe SIL 3 rated 'Black Channel' external communication over Ethernet.

Safety Configurations

An AADvance system supports the following safety configurations:

Fail-safe

I/O modules fail-safe in the most basic simplex system.

SIL 2

SIL 2 architectures for fail-safe low demand applications. All SIL 2 architectures can be used for energize or de-energize to trip applications.

- SIL 2 low demand architectures
- SIL 2 fail safe architectures
- SIL 2 fault tolerant input architectures
- SIL 2 triplicated input architectures
- SIL 2 fault tolerant output architectures
- SIL 2 fault tolerant input/output architectures

SIL 3

SIL 3 architectures:

- SIL 3 de-energize to trip applications.
- SIL 3 energize to action applications when fitted with dual digital output modules.

- SIL 3 simplex or dual output module architectures
- SIL 3 fail safe I/O fault tolerant processor architecture
- SIL 3 fault tolerant architecture
- SIL 3 fault tolerant simplex, dual and triple input architectures
- SIL 3 dual or triple processor architectures
- SIL 3 high demand applications where the required safe state is greater than 4 mA, when fitted with dual analogue output modules (A ‘safe state’ is an output configured to go to a specific value, or configured to hold last state)

Safety System Certification

TÜV is the safety certifying authority for an AADvance controller and they have certified the AADvance system to the following standards:

IEC 61508, Part 1-7:1998-2000	EN 50156-1:2004
EN 50178:1997	EN 54-2:1997, A1:2006 ¹
IEC 61511-1:2004	NFPA 72:2007
EN 61131-2:2007	NFPA 85:2015
EN 61326-3-1:2008	NFPA 86:2015
EN 61000-6-2:2005	
EN 61000-6-4:2007	

¹ The AADvance Analogue Output modules are not certified to EN 54-2.

NOTE	You can download a copy of the TUV certificate from their web site at " www.fs-products.com "
-------------	----------------------------------------------------------------------------------------------------------------------------------------

Performance and Electrical Specifications

Table 1: Controller Performance and Electrical Specifications

Attribute	Value
Performance Characteristics	
Safety Integrity Level	IEC 61508 SIL 2 IEC 61508 SIL 3 (depending on processor and I/O module configuration)
Safety level Degradation	1oo1D, 1oo2D, 2oo3D
Processor Modules supported	Three

I/O Modules supported	48 (8 or 16 channels modules)
Safety Accuracy Limit:	
Digital inputs	1.0 Vdc
Analogue inputs	200 µA
Sequence of Event Resolution	
• Processor Module (for internal Variables):	
Event Resolution	1 ms
Time Stamp Accuracy	Application Scan
• Digital Input Module:	
Event Resolution	1 ms
Time Stamp Accuracy	10 ms
Electrical Characteristics	
Supply voltage	Redundant 24 Vdc nominal, 18 Vdc to 32 Vdc range
Channel isolation (channel to channel and channel to chassis)	
Maximum withstand	± 1.5 kVdc withstand for 1 minute.

IMPORTANT Overall system power consumption, heat dissipation and weight can be estimated using the values given in the heat dissipation and weight data tables shown in this manual.

Scan Times

The controller processing scan times listed in the table are taken from a test system which used only production modules. The tests which were used to measure the scan times did not measure the effects of logic complexity and communications loading.

Table 2: Typical Module Scan Times

Module	Scan Time
9402	Digital input module, 24 Vdc, 16 channel
	Simplex
	1.676 ms
	Dual
	2.453 ms
	Triple
9432	Analogue input module 24 Vdc, 16 channel
	Simplex
	1.170 ms
	Dual
	1.965 ms
	Triple
	2.656 ms

9451	Digital output module, 24 Vdc, 8 channel Simplex Dual	1.174 ms 2.202 ms
9482	Analogue output module, 24 Vdc, 8 channel Simplex Dual	0.981 ms 1.761 ms
	Minimum cycle time overhead ¹	39.3 ms
	Scan overhead for each module	0.04 ms

¹ The minimum overhead to the cycle time is a feature of the AAdvance Workbench.

The scan time is:

$$\begin{aligned} \text{Scan time} &= 39.3 \text{ ms} \\ &+ \text{Sync time} \\ &+ \text{Total number of modules} * 0.04 \text{ ms} \\ &+ \Sigma (\text{Number of module groups} \times \text{scan time shown above}) \end{aligned}$$

Where:

Sync time is a function of the total number of modules defined according to the following table:

- 0..10 modules 20 ms
- 11..20 modules 22 ms
- 21..30 modules 24 ms
- 31..40 modules 27 ms
- 41..48 modules 32 ms.

Though the average scan time will be within 1 ms of the scan time calculated above the calculation does not take into account the effects of application logic and network communication, and individual scans can vary by up to +/- 4 ms around the average scan time.

Throughput time is the time from input change to output action. For asynchronous inputs the throughput times can be derived from the Scan time calculated above according to the following formulae:

- Minimum throughput time = Scan period + 7 ms
- Maximum throughput time = 2 x Scan time + 13 ms

An example configuration scan time:

System configuration includes T9432 Analogue input simplex modules x 30 and T9451 Digital output simplex modules x 18.

Total I/O modules = 48

Sync time = 32 ms

Scan time = $39.3 \text{ ms} + 32 \text{ ms} + (48 \times 0.04) \text{ ms} + (30 \times 1.170) \text{ ms} + (18 \times 1.174) \text{ ms} \Rightarrow 129.5 \text{ ms}$

Minimum throughput time = $129.5 \text{ ms} + 7 \text{ ms} \Rightarrow 136.5 \text{ ms}$

Maximum throughput time = $(2 \times 129.5) \text{ ms} + 13 \text{ ms} = 272.0 \text{ ms}$.

System Installation Environment

The installation environment can be a source of common cause failure so it is necessary that the installation assessment covers the environmental specification for the AAdvance system and includes the following:

- the prevailing climatic conditions
- type of area, e.g. is it a hazardous or non-hazardous area
- location of power sources
- earthing and EMC conditions

In some customer installations parts of the system can be installed in differing locations; in these cases the assessment must include each location.

Power Sources and Heat Dissipation Calculations

It is highly recommended that module supply power and field loop power consumption calculations are done to find out the heat dissipation before designing a suitable enclosure and making a decision about the installation environment (see topic "System Design for Heat Dissipation").

Safety Related System Installation Process

For a Safety Related System the installation process must also be in line with the following:



You must use the installation guidelines given in this manual and any installation and commissioning procedures that comply with applicable international or local codes and standards.

**CAUTION**

AADvance modules are suitable for use in Class I, Division 2, Groups A, B, C and D Hazardous locations or Non-hazardous locations only or equivalent.

**ATTENTION:**

Pour les modules AADvance sont utilisables dans Class I, Division 2, A, B, C et D pour un environnement dangereux ou pour un environnement non dangereux ou équivalente

Environment Standards

The AADvance system has been investigated to United States National Standard (s) UL508, 17th Edition and Canadian National Standard (s) C22.2 No 142, 1st Edition. The investigation covers the following modules and provides requirements for compliance to the standards for use in a non-hazardous and hazardous environments.

The AADvance controller has been investigated and approved by UL for use as Industrial Control Equipment in hazardous locations, Class I, Division 2, Groups A, B, C and D in North America.

The AADvance controller has been assessed for ATEX compliance. The UL Certification No. is DEMKO 11 ATEX 1129711X Rev 2; UL report number is 4786144521. The ATEX marking is Ex nA IIC T4 Gc.

Additionally the AADvance controller is approved under the IECEx certification scheme. The certificate number is IECEx UL 12.0032X

Installation Requirements for Non-Hazardous Environment

Investigation File Number E341697

Products Covered

The products investigated and approved:

Programmable Logic Controller Models: 9110 Processor Module; 9401 Digital Input Module; 9402 Digital Input Module, 16 Channel; 9431 Analogue Input Module; 9432 Analogue Input Module, 16 Channel; 9451 Digital Output Module; 9481 Analog Output Module; 9482 Analogue Output Module, 8 Channel.

Listed Accessories for use with PLCs: 9100 Processor Backplane; 9300 I/O Backplane; 9801 Digital Input Termination Assembly, Simplex; 9802 Digital Input Termination Assembly, Dual; 9803 Digital Input

Termination Assembly, TMR; 9831 Analogue input Termination Assembly, Simplex; 9832, Analogue Input Termination Assembly, Dual; 9833 Analogue Input Termination Assembly, TMR; 9851 Digital Output Termination Assembly, Simplex and 9852 Digital Output Termination Assembly, Dual; 9892 Digital Output Termination Assembly, Dual; 9881 Analogue Output Termination Assembly, Simplex; 9882 Analogue Output Termination Assembly, Dual.

Non-Hazardous Installation Requirements

Environmental

In a non-hazardous environment a system can be installed in an enclosure or on a support/wall; however, the enclosure or the area where it is installed must not be more than a Pollution Degree 2 or similar environment in accordance with IEC 60664-1:2007.

The surrounding air temperature ratings are:

- For the 9110 Processor module = 60 °C
- For all other I/O modules, base units and termination assemblies = 70 °C

Pollution Degree Definition

For the purpose of evaluating creepage distances and clearances, the following four degrees of pollution in the micro-environment are established:

- Pollution Degree 1: No pollution or only dry pollution occurs. The pollution has no influence.
- Pollution Degree 2: Only non-conductive pollution occurs except that occasionally a temporary conductivity caused by condensation is to be expected.
- Pollution Degree 3: Conductive pollution occurs or dry non-conductive pollution occurs which becomes conductive due to condensation which is to be expected.
- Pollution Degree 4: Continuous conductivity occurs due to conductive dust, rain or other wet conditions.

Installation Requirements for Hazardous Environment

The AADvance controller has been investigated and approved by UL for use as Industrial Control Equipment in hazardous locations, Class I, Division 2, Groups A, B, C and D in North America.

The AADvance controller has been assessed for ATEX compliance. The UL Certification No. is DEMKO 11 ATEX 1129711X Rev 1; UL report number is 4786144521. The ATEX marking is Ex nA IIC T4 Gc.

Additionally the AADvance controller is approved under the IECEx certification scheme. The certificate number is IECEx UL 12.0032X.

Installation Requirements

To comply with the standards the following conditions must be applied to the installation:



Special conditions for safe use

- Model 9110: The ambient temperature range is -25 °C to +60 °C (-13 °F to +140 °F).
- All other Models: The ambient temperature range is -25 °C to +70 °C (-13 °F to +158 °F).
- Subject devices are to be installed in an ATEX/IECEx Certified, IP54, tool accessible enclosure that has been evaluated to the requirements of EN 60079-0: 2012+A11:2013 and EN 60079-15:2010/IEC 60079-0 Ed 6 and IEC 60079-15 Ed 4. Enclosure is to be marked with the following: "Warning - Do not open when energized". After installation of subject devices into the enclosure, access to termination compartments must be dimensioned so that conductors can be readily connected. Grounding conductor should have a minimum cross sectional area of 3.31 mm².
- Subject devices are for use in an area of not more than pollution degree 2 in accordance with IEC 60664-1.
- Subject devices are to use conductors with a minimum conductor temperature rating of 85 °C.
- Subject devices are to be installed in the vertical orientation only.

AADvance meets the essential requirements of EN 60079-0:2012 + A11:2013 & EN 60079-15:2010 and IEC 60079-0 Ed 6 and IEC 60079-15 Ed 4.

File Number E251761

The AADvance controller investigation and approval is contained in the following file certifications:

- NRAG.E251761: Programmable Controllers for Use in Hazardous Locations Class I, Division 2, Groups A, B, C and D.

The products have been investigated using requirements contained in the following standards:

- ANSI/ISA 12.12.01-2013, Nonincendive Electrical Equipment for use in Class I and II, Division 2 and Class III, Division 1 and 2 Hazardous Locations.
- UL508, Industrial Control Equipment, Seventeenth edition, with revisions through and including April 15, 2010.
- NRAG7.E251761: Programmable Controllers for Use in Hazardous Locations Certified for Canada; Class I, Division 2, Groups A, B, C and D.

The products have been investigated using requirements contained in the following standards:

- CSA C22.2 No 213-M1987, Nonincendive Control Equipment for Use in Class I, Division 2, Hazardous Locations.
- CSA C22.2 No 142-M1987, Process Control equipment, Edition 1 - Revision date 1990-09-01.

Products Covered

The products investigated and approved:

Programmable Logic Controllers Models: 9110 Processor Module; 9401/2 Digital Input Module; 9431/2 Analogue Input Module; 9451 Digital output Module; 9482 Analogue Output Module.

Listed Accessories for use with PLCs: 9100 Processor Backplane; 9300 I/O Backplane; 9801 Digital Input Termination Assembly, Simplex; 9802 Digital Input Termination Assembly, Dual; 9803 Digital Input Termination Assembly, TMR; 9831 Analogue input Termination Assembly, Simplex; 9832, Analogue Input Termination Assembly, Dual; 9833 Analogue Input Termination Assembly, TMR; 9851 Digital Output Termination Assembly, Simplex.

Certifications for Safety System Applications in Hazardous Environments

ATEX Certificate

TYPE EXAMINATION CERTIFICATE



- [1] Equipment or Protective System intended for use in Potentially Explosive Atmospheres Directive 94/9/EC
- [2] Type Examination Certificate Number: DEMKO 11 ATEX 1129711X Rev.2
- [3] Equipment: Programmable Logic Controllers Models 9110 Processor, 9111 Processor, 9401 Digital Input, 9402 Digital Input, 9431 Analog Input, 9432 Analog Input, 9451 Digital Output, 9481 Analog Output, 9482 Output Input, 9100 Processor Backplane, 9101 Dual Backplane, 9300 I/O Backplane, 9801 Digital Input Termination Assembly, 9802 Digital Input Termination Assembly, 9803 Digital Input Termination Assembly, 9831 Analog Input Termination Assembly, 9832 Analog Input Termination Assembly, 9833 Analog Input Termination Assembly, 9851 Digital Output Termination Assembly, 9852 Digital Output Termination Assembly, 9881 Analog Output Termination Assembly, 9882 Analog Output Termination Assembly, 9892 Digital Output Termination Assembly.
- [4] Manufacturer: Rockwell Automation Ltd.
- [5] Address: Hall Road, Maldon, CM9 4LA, United Kingdom
- [6] This equipment and any acceptable variation thereto are specified in the schedule to this certificate and the documents therein referred to.
- [7] UL International Demko A/S certifies that this equipment has been found to comply with the Essential Health and Safety Requirements that relate to the design of Category 3 equipment, which is intended for use in potentially explosive atmospheres. These Essential Health and Safety Requirements are given in Annex II to the European Union Directive 94/9/EC of 23 March 1994.
- The examination and test results are recorded in confidential report no. 4786336921
- [8] Compliance with the Essential Health and Safety Requirements, with the exception of those listed in the schedule of this certificate, has been assessed by reference to Standards:

EN 60079-0:2012+A11:2013

EN 60079-15:2010

- [9] If the sign "X" is placed after the certificate number, it indicates that the equipment or protective system is subject to special conditions for safe use specified in the schedule to this certificate.
- [10] This Type examination certificate relates only to the design of the specified equipment, and not to specific items of equipment subsequently manufactured.
- [11] The marking of the equipment or protective system shall include the following:

II 3G Ex nA IIC T4 Gc

Certification Manager

Jan-Erik Storgaard

Certification Body

This is to certify that the sample(s) of the equipment described herein ("Certified Equipment") has been investigated and found in compliance with the Standard(s) indicated on this Certificate, in accordance with the ATEX Equipment Certification Program Requirements. This certificate and test results obtained apply only to the equipment sample(s) submitted by the manufacturer. UL did not select the sample(s) or determine whether the sample(s) provided were representative of other manufactured equipment. UL has not established Follow-Up Service or other surveillance of the equipment. The manufacturer is solely and fully responsible for conformity of the equipment to all applicable standards, specifications, requirements or directives. The test results may not be used, in whole or in part, in any other document without UL's prior written approval.

Date of issue: 2011-09-02

Re-issued: 2014-06-03



UL International Demko A/S, Borupvang 5A, 2750 Ballerup, Denmark
Tel. +45 44 85 65 65, info.dk@ul.com, www.ul.com

[13]

[14]

Schedule
TYPE EXAMINATION CERTIFICATE No.

DEMKO 11 ATEX 1129711X Rev. 2

Report: 4786336921

[15]

Description of Equipment:

These devices are low-power, open-type programmable logic controllers that are intended for installation in an ultimate enclosure. The 9000 Programmable Logic Controller Series consist of the following Models:

Model	Description	Circuit Number	Board Number
9100	Processor Backplane	151491	130662
9101	Dual Processor Backplane	152181	131022
9300	I/O Backplane	151501	130622
9110	Processor Model	151421	130642
		151431	130652
9111	Processor Model	151421	130642
		151431	130652
9401	Digital Input Model	151441	130682
9402	Digital Input Model – 16 Channel	151441	130682
		151751	130772
9431	Analog Input Model	151961	130682
9432	Analog Input Model – 16 Channel	151441	130682
		151751	130772
9481	Analog Output Model	151631	130842
9482	Analog Output Model - 8 Channel	151801	130852
		151791	130842
9451	Digital Output Model	151521	130722
		151531	130732
9801	Termination Assembly – 16 Channel Simplex Digital Input	151731	130812
9802	Termination Assembly – 16 Channel Dual Digital Input	151711	130802
9803	Termination Assembly – 16 Channel TMR Digital Input	151561	130782
9831	Termination Assembly – 16 Channel Simplex Analog Input	151721	130812
9832	Termination Assembly – 16 Channel Dual Analog Input	151701	130802
9833	Termination Assembly – 16 Channel TMR Analog Input	151551	130782
9851	Termination Assembly – 8 Channel Simplex Digital Output	151741	130822
9852	Termination Assembly – 8 Channel Dual Digital Output	151691	130792
9892	Termination Assembly- 8 Channel Dual Digital Output	152621	131212
9881	Termination Assembly - 8 Channel Simplex Analog Output	151821	130872
9882	Termination Assembly - 8 Channel Dual Analog Output	151811	130862

Model 9100 Processor Backplane and 9101 Dual Processor Backplane are for use with Model 9110 and 9111 Processors. Model 9300 I/O Backplane is for use with all other Models. Subject devices are all marked Ex nA IIC T4 Gc.

Temperature range

Models 9110 and 9111: The ambient temperature range is -25 °C to +60 °C
 All other Models: The ambient temperature range is -25 °C to +70 °C



[13]

[14]

Schedule
TYPE EXAMINATION CERTIFICATE No.
DEMKO 11 ATEX 1129711X Rev. 2
Report: 4786336921

Electrical data

Model	Backplane Ratings		Input/Output Ratings
	Voltage(Vdc)	Current (mA)	
9100	18-32	10.4A (400mA per slot)	-
9101	18-32	10.4A (400mA per slot)	-
9300	18-32	9.6A (400mA per slot)	-
9110	18-32	380	-
9111	18-32	380	-
9401	18-32	260	Input: 18-32Vdc @ 24 mA
9402	18-32	260	Input: 0-32Vdc @ 6.5 mA
9431	18-32	260	Input: 0-32Vdc @ 6.5 mA
9432	18-32	260	Input: 18-32Vdc @ 24 mA
9481	18-32	260	Output: 18-32Vdc/0-20mA
9482	18-32	260	Output: 18-32Vdc/0-20mA
9451	18-32	165	Output: 18-32Vdc @ 0.5A, Pilot Duty 16VA, 1.5A Inrush
9801	0-32	6.5	-
9802	0-32	6.5	-
9803	18-32	0-24	-
9831	18-32	0-24	-
9832	18-32	0-24	-
9833	0-32	6.5	-
9851	18-32	500	-
9852	18-32	500	-
9892	18-32	500	-
9881	18-32	0-24	-
9882	18-32	0-24	-

Routine tests

None

[16]

Descriptive Documents

Project Report No.: 4786336921 (Hazardous Location Testing)

Drawings:**Description:**

	Drawing No.:	Rev. Level:	Date:
Model 9100 Schematic (8 Pages)	130662	O	2009-12-17
Model 9101 Schematic (6 Pages)	131022_1715A2A	D7	2011-05-31
Model 9300 Schematic (2 Pages)	130622	E	2008-06-07
Model 9110 and 9111 Schematic – Board No. 151421 (25 Pages)	130642	N1	2011-09-13
Model 9110 and 9111 Schematic – Board No. 151431 (9 Pages)	130652	P5	2011-05-31
Models 9401, 9402, 9431 and 9432 Schematic - Board Nos. 151441 and 151961 (67 Pages)	130682	AE3	2012-05-18
Model 9481 and 9482 Schematic- Board Nos. 151631 and 151791 (41 Pages)	130842	M10	2013-09-26
Model 9482 Schematic - Board No. 151801 (56 Pages)	130852	H4	2013-09-26
Model 9451 Schematic – Board No. 151521 (42 Pages)	130722	R2	2011-05-31
Model 9451 Schematic – Board No. 151531 (21 Pages)	130732	O	2009-07-01



[13]
[14]

**Schedule
TYPE EXAMINATION CERTIFICATE No.
DEMKO 11 ATEX 1129711X Rev. 2
Report: 4786336921**

Description:	Drawing No.:	Rev. Level:	Date:
Model 9801 and 9831 Schematic (6 Pages)	130812	H	2009-01-22
Model 9802 and 9832 Schematic (7 Pages)	130802	C	2008-04-09
Model 9803 and 9833 Schematic (7 Pages)	130782	J	2009-04-23
Model 9851 Schematic (2 Pages)	130822	C	2008-01-22
Model 9852 Schematic (2 Pages)	130792	F	2008-01-23
Model 9402 and 9432 Schematic - Board no. 151751 (62 Pages)	130772	F1	2012-05-25
Model 9881 Schematic	130872	A	2009-04-17
Model 9882 Schematic	130862	C1	2011-04-12
Model 9892 Schematic	131212	A	2011-10-17
Model 9100 Construction Drawing (2 Pages) - representative of Model 9101	151490-GA	G1	2012-07-27
Model 9300 Construction Drawing (6 Page)	9300-GA	3	2013-10-18
Model 9110 Construction Drawing (3 Pages)	9110-GA	3	2012-03-13
Model 9401 Construction Drawing (2 Pages) - represents the Processors 9110 and 9111 and all I/O Devices	9401-GA	2	2008-09-24
Model 9801 Construction Drawing (1 Page) - represents all termination assemblies	9801-GA	4	2013-07-30
Marking Label 9100, 9300 (1 Page)	274850	F	2013-11-04
Marking Label 9300 (1 Page)	274070	B	2011-02-11
Marking Label 9100 (1 Page)	274680	D	2011-08-25
Marking Label All I/O Modules (2 Page)	275750	D	2013-11-04
Marking Label 9110, 9101, All I/O Moduels (3 Page)	275520	F	2012-02-14
Marking Label 9110 (1 Page)	273570	E	2013-11-04
Marking Label 9101 (1 Page)	276250	E	2012-08-02
Marking Label - All Termination Assemblies except 9851 and 9852 (1 Page)	276210	C	2011-08-26
Marking Label 9851 and 9852 (1 Page)	276260	C	2011-08-26
Marking Label (Model Number only) 9801 (1 Page)	274270	C	2011-02-15
Marking Label (Model Number only) 9802 (1 Page)	274280	E	2011-05-01
Marking Label (Model Number only) 9803 (1 Page)	274290	E	2011-05-03
Marking Label (Model Number only) 9831 (1 Page)	274300	C	2011-02-15
Marking Label (Model Number only) 9832 (1 Page)	274310	E	2011-05-01
Marking Label (Model Number only) 9833 (1 Page)	274320	E	2011-05-03
Marking Label (Model Number only) 9851 (1 Page)	274240	C	2011-02-11
Marking Label (Model Number only) 9852 (1 Page)	274250	D	2012-05-14
Marking Label (Model Number only) 9881 (1 Page)	275060	B	2011-02-15
Marking Label (Model Number only) 9882 (1 Page)	275070	C	2012-05-17
Marking Label (Model Number only) 9892 (1 Page)	276370	A	2011-12-14



[13]

[14]

Schedule
TYPE EXAMINATION CERTIFICATE No.
DEMKO 11 ATEX 1129711X Rev. 2
Report: 4786336921

Description:	Drawing No.:	Rev. Level:	Date:
Marking Label (Model Number only) 9882 (1 Page)	275070	C	2012-05-17
Marking Label (Model Number only) 9892 (1 Page)	276370	A	2011-12-14
System Build Manual - Installation Instructions (107 Pages)	553632	09A	2014-05
Model 9100 and 9101 Critical Component List (2 Pages)	130669_UL	B	2011-08-24
Model 9110 Critical Component List – Circuit Number 151421 (3 Pages)	130649_UL	C	2011-08-24
Model 9110 Critical Component List – Circuit Number 151431 (4 Pages)	130659_UL	B	2011-08-24
Model 9300 Critical Component List (2 Pages)	130629_UL	B	2011-08-25
Model 9401 and 9402 Critical Component List (4 Pages)	130689(9401_9402)_UL	E	2011-10-24
Model 9402 Critical Component List (2 Pages)	130779_UL	B	2011-08-24
Model 9431 and 9432 Critical Component List (3 Pages)	130689(9431_9432)_UL	E	2011-10-24
Model 9481 and 9482 Critical Component List (6 Pages)	130849(9481_9482)_UL	E	2012-02-09
Model 9482 Critical Component List (3 Pages)	130859_9482_UL	D	2012-02-09
Model 9451 Critical Component List – Circuit Number 151521 (4 Pages)	130729_UL	C	2012-02-09
Model 9451 Critical Component List – Circuit Number 151531 (3 Pages)	130739_UL	B	2011-08-24
Model 9801 Critical Component List (3 Pages)	130819_9801_UL	B	2011-08-25
Model 9802 Critical Component List (3 Pages)	130809_9802_UL	B	2011-08-25
Model 9803 Critical Component List (3 Pages)	130789_9083_UL	C	2011-08-24
Model 9831 Critical Component List (3 Pages)	130819_9831_UL	B	2011-08-25
Model 9832 Critical Component List (3 Pages)	130809_9832_UL	C	2011-08-25
Model 9833 Critical Component List (3 Pages)	130789_9833_UL	B	2011-08-25
Model 9851 Critical Component List (3 Pages)	130829_9851_UL	B	2011-08-25
Model 9852 Critical Component List (3 Pages)	130799_9852_UL	B	2011-08-25
Model 9881 Critical Component List (2 Pages)	130879_9881_UL	A	2011-08-04
Model 9882 Critical Component List (2 Pages)	130869_9882_UL	A	2011-08-04
Model 9892 Critical Component List (3 Pages)	131219_9892_UL	A	2013-12-23
T9000.DIB Product Information	554155	4	2014-05

[17]

Special conditions for safe use:

- Models 9110 and 9111: The ambient temperature range is -25 °C to +60 °C
- All other Models: The ambient temperature range is -25 °C to +70 °C
- Subject devices are to be installed in an ATEX Certified, IP54, tool accessible enclosure that has been evaluated to the requirements of EN 60079-0: 2012+A11:2013 and EN 60079-15: 2010. Enclosure is to be marked with the following: "Warning - Do not open when energized". After installation of subject devices into the enclosure, access to termination compartments shall be dimensioned so that conductors can be readily connected. Grounding conductor should have a minimum cross sectional area of 3.31 mm².
- Subject devices are for use in an area of not more than pollution degree 2 in accordance with IEC 60664-1.
- Subject devices are to use conductors with a minimum conductor temperature rating of 85°C
- Subject devices are to be installed in the vertical orientation only

[18]

Essential Health and Safety Requirements

Met by compliance with the standards EN 60079-0:2012+A11:2013, EN 60079-15:2010



IECEx UL Certificate

		IECEx Certificate of Conformity	
INTERNATIONAL ELECTROTECHNICAL COMMISSION IEC Certification Scheme for Explosive Atmospheres <small>for rules and details of the IECEx Scheme visit www.iecex.com</small>			
Certificate No.:	IECEx UL 12.0032X	issue No.:	2
Status:	Current	<small>Certificate history: Issue No. 2 (2014-5-28) Issue No. 1 (2014-1-30) Issue No. 0 (2012-8-27)</small>	
Date of Issue:	2014-05-28	Page 1 of 4	
Applicant:	Rockwell Automation Ltd. Hall Road, Maldon CM9 4LA United Kingdom		
Electrical Apparatus:	Programmable Logic Controllers		
<i>Optional accessory:</i>			
Type of Protection:	Non-Sparking "nA"		
Marking:	Ex nA IIC T4 Gc		
<i>Approved for issue on behalf of the IECEx Certification Body:</i>	Paul T. Kelly		
Position:	Principal Engineer, Global Hazardous Locations		
<i>Signature: (for printed version)</i>	 <hr/>		
Date:	2014-05-28		
1. This certificate and schedule may only be reproduced in full. 2. This certificate is not transferable and remains the property of the issuing body. 3. The Status and authenticity of this certificate may be verified by visiting the Official IECEx Website .			
<i>Certificate issued by:</i>			
UL LLC 333 Pfingsten Road Northbrook IL 60062-2096 United States of America			



	<h2>IECEx Certificate of Conformity</h2>						
<p>Certificate No.: IECEx UL 12.0032X</p> <p>Date of Issue: 2014-05-28 Issue No.: 2</p> <p>Page 3 of 4</p>							
Schedule							
<p>EQUIPMENT: <i>Equipment and systems covered by this certificate are as follows:</i></p> <p>These devices are low-power, open-type programmable logic controllers that are intended for installation in an ultimate enclosure. The 9000 Programmable Logic Controller Series consist of the following modules:</p> <p>Please see Annex for additional details.</p>							
<p>CONDITIONS OF CERTIFICATION: YES as shown below:</p> <table border="1"><tr><td>■ Models 9110 and 9111: The ambient temperature range is -25 °C to +60 °C.</td></tr><tr><td>■ All other Models: The ambient temperature range is -25 °C to +70 °C.</td></tr><tr><td>■ Subject devices are to be installed in an IECEx Certified, IP54, tool accessible enclosure that has been evaluated to the requirements of IEC 60079-0 Ed. 6 and IEC 60079-15 Ed. 4. Enclosure is to be marked with the following: "Warning - Do not open when energized". After installation of subject devices into the enclosure, access to termination compartments shall be dimensioned so that conductors can be readily connected. Grounding conductor should have a minimum cross sectional area of 3.31 mm².</td></tr><tr><td>■ Subject devices are for use in an area of not more than pollution degree 2 in accordance with IEC 60664-1.</td></tr><tr><td>■ Subject devices are to use conductors with a minimum conductor temperature rating of 85°C.</td></tr><tr><td>■ Subject devices are to be installed in the vertical orientation only.</td></tr></table>		■ Models 9110 and 9111: The ambient temperature range is -25 °C to +60 °C.	■ All other Models: The ambient temperature range is -25 °C to +70 °C.	■ Subject devices are to be installed in an IECEx Certified, IP54, tool accessible enclosure that has been evaluated to the requirements of IEC 60079-0 Ed. 6 and IEC 60079-15 Ed. 4. Enclosure is to be marked with the following: "Warning - Do not open when energized". After installation of subject devices into the enclosure, access to termination compartments shall be dimensioned so that conductors can be readily connected. Grounding conductor should have a minimum cross sectional area of 3.31 mm ² .	■ Subject devices are for use in an area of not more than pollution degree 2 in accordance with IEC 60664-1.	■ Subject devices are to use conductors with a minimum conductor temperature rating of 85°C.	■ Subject devices are to be installed in the vertical orientation only.
■ Models 9110 and 9111: The ambient temperature range is -25 °C to +60 °C.							
■ All other Models: The ambient temperature range is -25 °C to +70 °C.							
■ Subject devices are to be installed in an IECEx Certified, IP54, tool accessible enclosure that has been evaluated to the requirements of IEC 60079-0 Ed. 6 and IEC 60079-15 Ed. 4. Enclosure is to be marked with the following: "Warning - Do not open when energized". After installation of subject devices into the enclosure, access to termination compartments shall be dimensioned so that conductors can be readily connected. Grounding conductor should have a minimum cross sectional area of 3.31 mm ² .							
■ Subject devices are for use in an area of not more than pollution degree 2 in accordance with IEC 60664-1.							
■ Subject devices are to use conductors with a minimum conductor temperature rating of 85°C.							
■ Subject devices are to be installed in the vertical orientation only.							



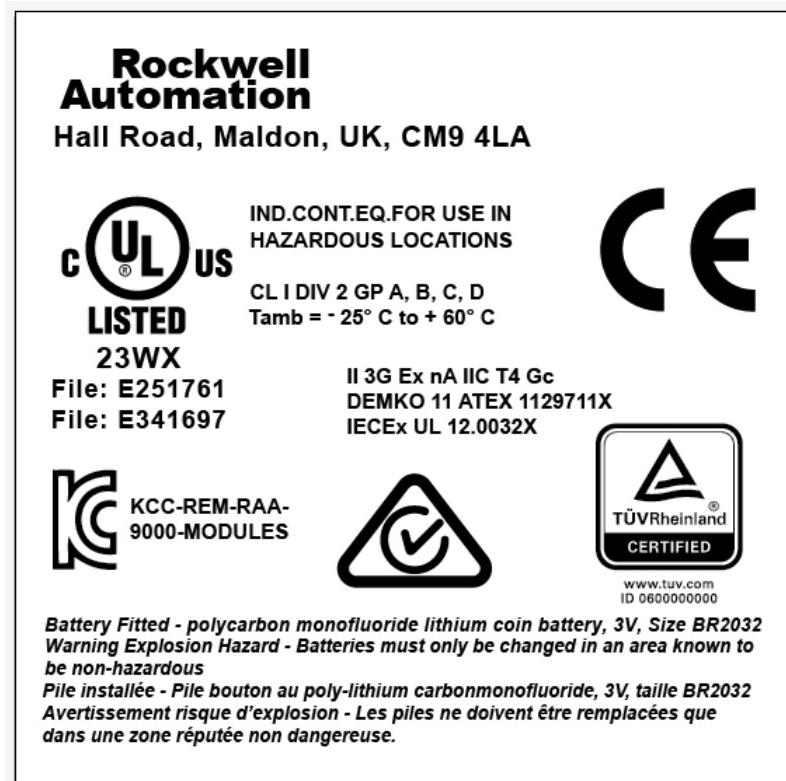
Annexe for IECEx UL 12.0032

Model	Description	Backplane Ratings		Input/Output Ratings
		Voltage (Vdc)	Current (mA)	
9100	Processor Backplane	18-32	10.4A (400mA per slot)	-
9101	Dual Processor Backplane	18-32	10.4A (400mA per slot)	-
9300	I/O Backplane	18-32	9.6A (400mA per slot)	-
9110	Processor Module	18-32	380	-
9111	Processor Module	18-32	380	-
9401	Digital Input Module	18-32	260	Input: 18-32Vdc @ 24 mA
9402	Digital Input Module – 16 Channel	18-32	260	Input: 0-32Vdc @ 6.5 mA
9431	Analogue Input Module	18-32	260	Input: 0-32Vdc @ 6.5 mA
9432	Analogue Input Module – 16 Channel	18-32	260	Input: 18-32Vdc @ 24 mA
9481	Analogue Output Module	18-32	260	Output: 18-32Vdc/ 0-20mA
9482	Analogue Output Module - 8 Channel	18-32	260	Output: 18-32Vdc/ 0-20mA
9451	Digital Output Module	18-32	165	Output: 18-32Vdc @0.5A, Pilot Duty 16VA, 1.5A Inrush
9801	Termination Assembly – 16 Channel Simplex Digital Input	0-32	6.5	-
9802	Termination Assembly – 16 Channel Dual Digital Input	0-32	6.5	-
9803	Termination Assembly – 16 Channel TMR Digital Input	18-32	0-24	-
9831	Termination Assembly – 16 Channel Simplex Analogue Input	18-32	0-24	-
9832	Termination Assembly – 16 Channel Dual Analogue Input	18-32	0-24	-
9833	Termination Assembly – 16 Channel TMR Analogue Input	0-32	6.5	-
9851	Termination Assembly – 8 Channel Simplex Digital Output	18-32	500	-
9852	Termination Assembly – 8 Channel Dual Digital Output	18-32	500	-
9892	Termination Assembly-8 Channel Dual Digital Output	18-32	500	-
9881	Termination Assembly - 8 Channel Simplex Analogue Output	18-32	0-24	-
9882	Termination Assembly - 8 Channel Dual Analogue Output	18-32	0-24	-

Module 9100 Processor Backplane and 9101 Dual Processor Backplane are for use with Module 9110 and 9111 Processors. Module 9300 I/O Backplane is for use with all other Modules. Subject devices are all marked Ex nA IIC T4 Gc.

Module Label

The following label information must be attached to each module.



KCC-EMC Registration

1. A급 기기 (업무용 방송통신기기): 이 기기는 업무용(A급)으로 전자파적합등록을 한 기기이오니 판매자 또는 사용자는 이 점을 주의하시기 바라며, 가정외의 지역에서 사용하는 것을 목적으로 합니다.
 - Translation: Class A device (Broadcasting Communication Device for Office Use): This device obtained EMC registration for office use (Class A), and may be used in places other than home. Sellers and/or users need to take note of this.

The AADvance Workbench and Software Development Environment

The AADvance software lets you design one complete control strategy, and then target parts of the strategy to individual controllers. Interaction between the resources is automatic, significantly reducing the complexity of configuration in a multi-resource system. Programs can be simulated and tested on the workstation computer before downloading to the controller.

The workstation software is compliant with the IEC-61131 industrial standard and has several powerful features:

- the regulation of the flow of control decisions for an interacting distributed control system
- providing for the consistency of data
- providing a means for synchronous operation between devices
- eliminating the need to have separate synchronous schemes
- easing the development and maintenance of robust systems

The Workbench is a software development environment for a controller. It lets you create local and distributed control applications using the five languages of IEC 61131-3. (Instruction List (IL) and Sequential Function Chart (SFC) languages are not supported by AADvance Workbench 2.0). Engineers can use one language or a combination that best suits their knowledge and programming style and the type of application.

The Workbench is a secure development environment. There is also a Program Enable key that must be plugged into the processor base unit to allow the user to modify and download the application resource or access the AADvance Discover tool to set or change the controller IP address. The Program Enable Key when it is removed protects the application from unauthorized access.

The development environment includes:

- tools for program development
- program documentation
- function block library management
- application archiving
- database configuration
- import/export utilities
- on-line monitoring
- off-line simulation and controlled on-line changes
- Programs can be simulated and tested on the computer before downloading to the controller hardware. Also supplied are a set of configuration tools that enables you to define the hardware architecture in the software; set up the processor functionality; and connect application variables to the Workbench application resource program that will monitor processor and I/O module status information and report I/O channel data values to the Workbench. Resource Control applications can be distributed across several hardware platforms, communicating with each other through secure networks.

Operating Systems (32 or 64 bit)

The minimum workstation requirements for the application development software are as follows:

- Microsoft Windows XP Service Pack 3



CAUTION: Do not use XP Professional x64 Edition

- Windows Vista
- Windows 7
- Microsoft Windows Server 2003
- Microsoft Windows Server 2008

IMPORTANT For Workbench 1.3 Network Licensing - Windows 64-bit version will only work with the USB license key and will not recognize a Workbench software license key.

Hardware:

- 1.6 GHz CPU
- 1 GB RAM (32-bit) or 2 GB RAM (64-bit) (add 512 MB if running in a virtual machine)
- DirectX 9 capable video card running at 1024 x 768 resolution display
- 5,400 RPM hard disk
- 3 GB available hard disk space
- DVD drive or network connection, to read software distribution files

NOTE

If the application is Workbench 1.3 and adopts the USB dongle licensing option the workstation PC will require one free USB port.

- Network port (10/100 Base T Ethernet), for communications with the controller

It is recommended that the PC has a 2.2 GHz or higher CPU; 1,024 MB or more RAM, a 1,280 x 1,024 display and a 7,200 RPM or higher hard disk.

It is also recommended that the hard disk has at least 10 GB free space. This provides sufficient space to hold the distribution zip file, the

unzipped source files and the installed program files, and also enough space for Windows to operate reasonably quickly. You can get back a lot of this space by deleting the source files after finishing the installation.

Importing and Exporting Data

The AADvance Workbench can import and export existing data in standard file formats such as Microsoft Excel.

AADvance Workbench Licensing

The AADvance Workbench is licensed software. There are three types of license: full, single controller and demo.

- The single controller license is applicable for applications which use only one controller. The software features which add a second or subsequent controller to the project are disabled, and you cannot open an existing project which uses more than one controller.
- The full license supplies all of the features of the AADvance Workbench. It is applicable for applications with one or more controllers.
- The demo license is like a full license, but with a time limit. You can use all of the features of the AADvance Workbench for up to 30 days after first running the AADvance Workbench is first run.

A demo license is supplied free of charge for a first installation on a computer. You change the demo license to a single controller license or a full license by purchasing an unlock code from Rockwell Automation, and entering the code into the software. When you use the demo license, the AADvance Workbench displays a Demo License window each time you try to open a project. The window includes the contact details at Rockwell Automation required for purchasing a license.

If you try to use the demo license for more than 30 days, the license expires. You cannot open a project or create a new one until you purchase a license.

Corrective Maintenance and Module Replacement

Scheduled maintenance consists of checking the I/O Module calibrations and proof tests. Detailed scheduled and corrective maintenance information is given in the AADvance Troubleshooting and Maintenance Manual Doc No: 553634. Corrective maintenance is by module replacement and where required fuse replacement in Termination Assemblies. In dual and triple modular redundant configurations, you can

remove a module and install a new one without interrupting the system operation. In simplex configurations removing a module will interrupt the system operation. However, certain restrictions apply on module replacement timing for Safety Related systems (see the AADvance Safety Manual - 553630 for guidance).

Field connection wiring is attached at the connectors on the termination assemblies. Ethernet and Serial data connections are made at the T9100 Processor Base Unit. There are no physical links needed to be set up on any modules or base units. Standard modules are used for all the different configurations.

IMPORTANT Processor modules must be replaced with a module containing the same firmware revision, you cannot use processor modules with different firmware revisions on the same controller.

TUV Approved Operating System

The AADvance system runs an IEC 61508 approved operating system and the overall system is certified to IEC 61508, Part 1-7: 1998 - 2000 SIL 3.

Main Components

An AADvance controller is built from durable processor and I/O modules and assemblies designed to IEC 61508 standards for safety systems and runs the AADvance Workstation software. Field devices connect direct to a controller and external communication links over Ethernet and serial links use a secure protocol.

Physical Features

A new and innovative style characteristic of the AADvance controller is the design of the hardware. All the modules and assemblies connect together easily without the need for inter-module wiring.



CAUTION: The controller contains static sensitive components. When the controller is installed attach a label that is clearly visible to tell operators to follow anti-static precautions when they touch or move modules. Failure to follow these instructions can result in damage to the equipment.

Environmental Specification

An AADvance system can be installed in a non-hazardous or a hazardous environment. In a non-hazardous environment a system does not have to be installed in an enclosure; however, the area where it is installed must maintain a Pollution Degree 2 environment (IEC 60664-1).

The following environmental specification defines the minimum environmental conditions for an AADvance controller installation. Additional conditions apply to systems installed in a Hazardous environment.

Table 3: Environmental Specification

Attribute	Value
Operating Temperature Range: For use in Hazardous Environments:	
Processor Modules	-25 °C to +60 °C (-13 °F to +140 °F)
I/O Modules and Termination Assemblies	-25 °C to +70 °C (-13 °F to +158 °F)
For use in Non-hazardous Environments:	-25 °C to +70 °C (-13 °F to +158 °F)
Processor Modules, I/O modules and Termination Assemblies	
Storage and Transport Temperature Range	-40 °C to +70 °C (-40 °F to +158 °F)
Module Surface Temperature (during usual operation)	43° C (109 °F) ± 2 °C
Humidity	
Operating	10 % to 95 % RH, non-condensing
Storage and Transport	10 % to 95 % RH, non-condensing
Vibration	
Functional Stress	5 Hz to 9 Hz
Continuous	1.7 mm amplitude
Occasional	3.5 mm amplitude
Withstand	10 Hz to 150 Hz
Acceleration	0.1 g in 3 axes
Endurance	10 Hz to 150 Hz
Acceleration	0.5 g in 3 axes
Shock	15 g peak, 11 ms duration, ½ sine
Altitude	
Operating	0 to 2,000 m (0 to 6,600 ft.)

Storage and Transport	0 to 3,000 m (0 to 10,000 ft.) This equipment must not be transported in unpressurized aircraft flown above 10,000 ft.
Electromagnetic Interference	Tested to the following standards: EN 61326-1:2006, Class A; EN 61326-3-1:2008, EN 54-4: 1997, A1; EN 61131-2:2007; EN 62061:2005.
Hazardous Location Capability	Suitable for Class I Div 2 Groups A, B, C and D

¹ There is no specific protection against liquids.

Product Dimensions

A typical controller arrangement is shown with processor modules installed on the processor base unit and an I/O base unit mated with the processor base unit. I/O modules are installed on the base unit and a termination assembly plugged into the I/O base unit.

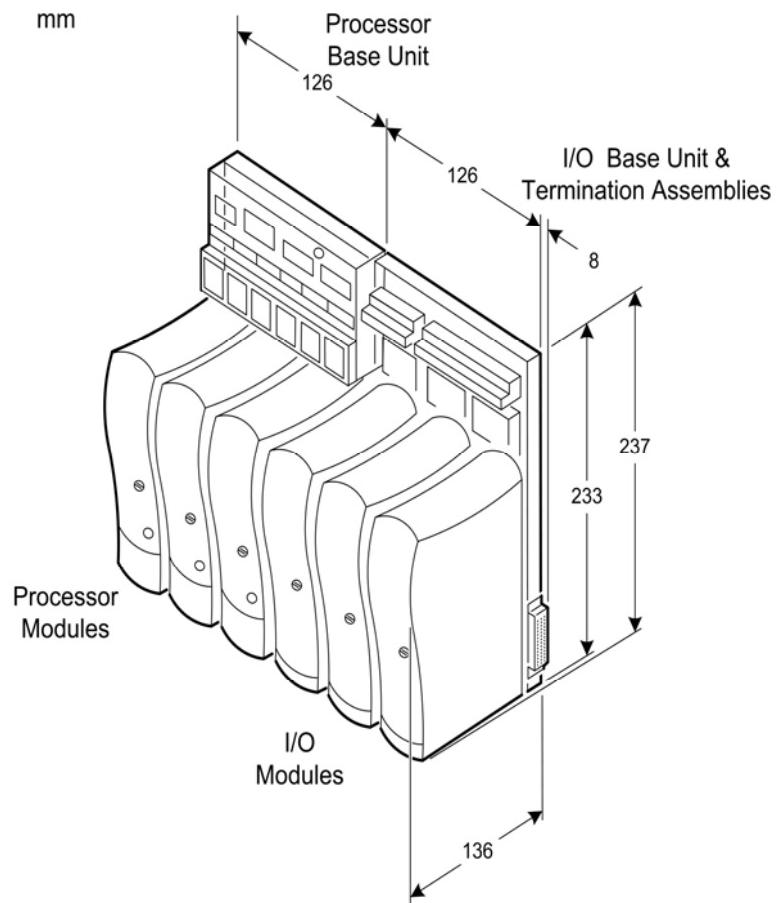


Table 4: Summary of Dimensions

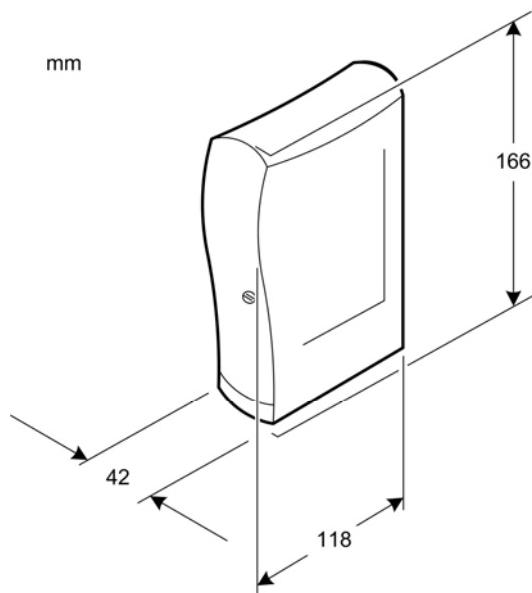
Attribute	Value
Base unit dimensions ($H \times W \times D$), approx.	233 mm \times 126 mm \times 18 mm (see text) (9-1/4 in. \times 5 in. \times 3/4 in.)
Module dimensions ($H \times W \times D$), approx.	166 mm \times 42 mm \times 118 mm (6-1/2 in. \times 1-5/8 in. \times 4-5/8 in.)

The depth of the base unit (18 mm) excludes the parts of the backplane connectors that mate inside the module connectors. Adding the depth of a module (118 mm) to the depth of the base unit gives the overall depth of the controller assembly at 136 mm.

Module Dimensions

All modules have the same dimensions.

Figure 1: Module Dimensions



Compact Module Design

Each processor and I/O module has a flame-retardant and impact-resistant plastic cover. The cover is designed to help ventilation and heat dissipation occur naturally without the need for fan assisted cooling. Processor and I/O modules fit onto standardized base units. Base units plug together by side connectors and are securely held in position by specially designed plastic clips which cannot corrode or seize up. Modules are retained by a locking screw which is easy to access from the

front.

Figure 2: An AADvance Module



NOTE Standard AADvance modules have a plastic casing and are rated IP20: Protected against solid objects over 12 mm (1/2 in.) for example "fingers". There is no specific protection against liquids.

Module Polarization Keying

For each I/O Module there is a matched termination assembly. The controller incorporates module polarization keying to make sure that they are correctly mated when installed. Sockets on the rear end plate align and mate with coding pins found on the termination assembly. The

alignment of the sockets and pins make sure that only the matched I/O modules and termination assemblies can be mated.

Figure 3: Coding Sockets



Module Locking Mechanism

Figure 4: Locking Screw



Each module carries a locking mechanism, which secures the module onto its base unit. The locking mechanism is in the form of a clamp screw, which can be seen on the front panel of the module and engaged by a quarter turn of a flat blade screwdriver. The module senses the locking mechanism position and notifies the controller accordingly. This acts as an interlock device and prevents the module from going on-line when it is not in the locked position.

Field Wiring

Field device wiring connections are made to industry-standard screw terminal blocks on the termination assemblies. Terminals are easy to access without needing to dismantle assemblies. The specification for the

field wiring sizes is given in the topic "Power and External Connector Wiring Requirements".

This illustration shows field wiring connections at the termination assemblies.

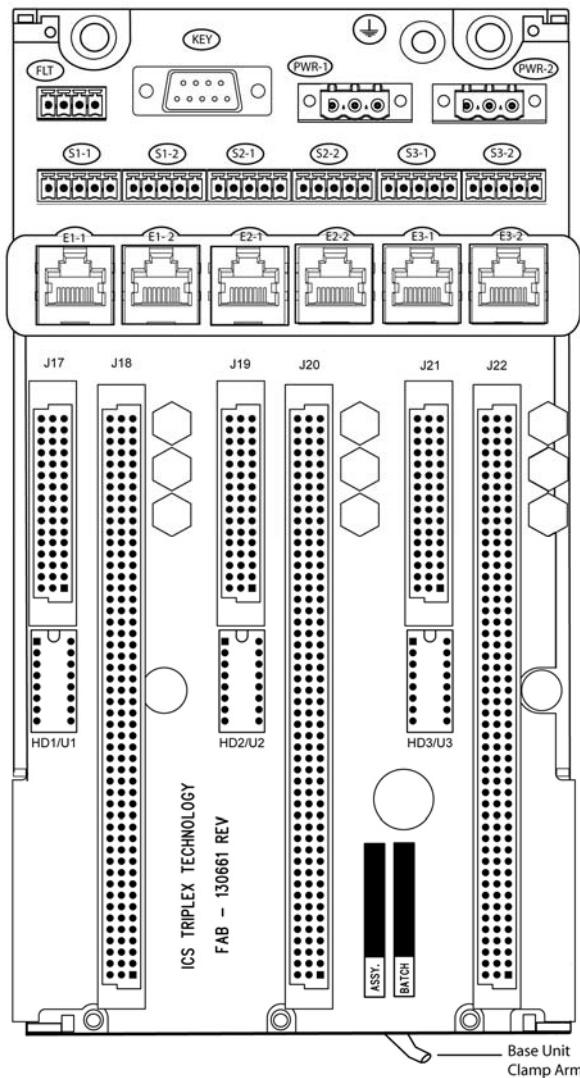
Figure 5: Field Wiring Connections



NOTE The recommended torque for termination assembly screw connectors is 5 Nm

Processor Base Unit

A processor base unit holds up to three processor modules:



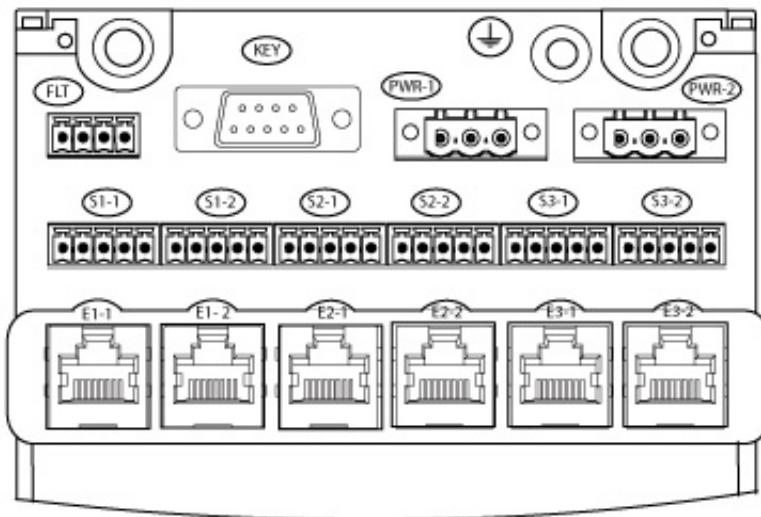
External Ethernet, Serial Data and Power Connections

The processor base unit external connections are:

- Earthing Stud
- Ethernet Ports (E1-1 to E3-2)
- Serial Ports (S1-1 to S3-2)
- Redundant +24 Vdc powers supply (PWR-1 and PWR-2)

- Program Enable security key (KEY)
- The FLT connector (currently not used).

Figure 6: External Connectors on the Processor Base Unit



The power connections supply all three modules with redundant power, each processor module each have two Serial ports and two Ethernet port connectors. The KEY connector supports all three processor modules and prevents access to the application unless the Program Enable key is inserted.

Serial Communications Ports

The serial ports (S1-1 and S1-2; S2-1 and S2-2; S3-1 and S3-2) support the following signal modes depending on use:

- RS485fd: A four-wire full duplex connection that features different busses for transmit and receive. This selection must also be used when the controller is acting as a Modbus master using the optional four-wire definition specified in Section 3.3.3 of the Modbus-over-serial standard.
- RS485fdmux: A four-wire full-duplex connection with tri-state outputs on the transmit connections. This must be used when the controller is acting as a Modbus slave on a four-wire bus.
- RS485hdmux: A two-wire half duplex connection applicable for master slave or slave use. This is shown in the Modbus-over-serial standard.

Processor Back-up Battery

The 9110 processor module has a back-up battery that powers its internal Real Time Clock (RTC) and a part of the volatile memory (RAM). The battery only supplies power when the processor module is no longer powered from the system power supplies. The specific functions that the battery maintains on complete loss of power are:

- Real Time Clock - The battery supplies power to the RTC chip itself.
- Retained Variables - Data for retained variables is stored at the end of each application scan in a portion of RAM, backed up by the battery. On restoration of power the retained data is loaded back into the variables assigned as retained variables for use by the application.
- Diagnostic logs - The processor diagnostic logs are stored in the portion of RAM backed by the battery.

The battery has a design life of 10 years when the processor module is continually powered; for processor modules that are un-powered, the design life is up to 6 months. Battery design life is based on operating at a constant 25 ° C and low humidity. High humidity, temperature and frequent power cycles will shorten the operational life of the battery.

Low Battery Alarm

A variable is available in the Workbench that can be set up and report the battery status. It will give an alarm and set a warning light on the processor front panel when the battery voltage is low.

Disabling the Low Battery Alarm

For applications that do not require Real Time Clock functionality, or there are specific constraints, for example, the controller is in an inaccessible location, that make it necessary to remove the battery when the system is installed and set up, the battery failure alarm can be disabled at the Workbench.

Battery Location

The battery is supplied separately and inserted into a slot behind a removable cover on the front panel of the processor module. The battery position is shown in the illustration:



CAUTION: The battery may explode if mistreated. Do not recharge, disassemble or dispose of in a fire.



Battery Specification:

A Polycarbon monofluoride Lithium Coin Battery with a nominal voltage of 3V; Nominal capacity (mAh) 190; Continuous standard load (mA) 0.03; Operating temperature range -30°C to +80°C, manufactured by Panasonic.

Processor Maintenance Socket

Behind the removal cover on the processor front panel is a maintenance socket SK1. This socket is for maintenance use only.

WARNING



SK1 is for maintenance only. When AADvance is installed in a hazardous location power must be disconnected or the area known to be free of ignitable concentrations of flammable gases or vapours when using this socket.

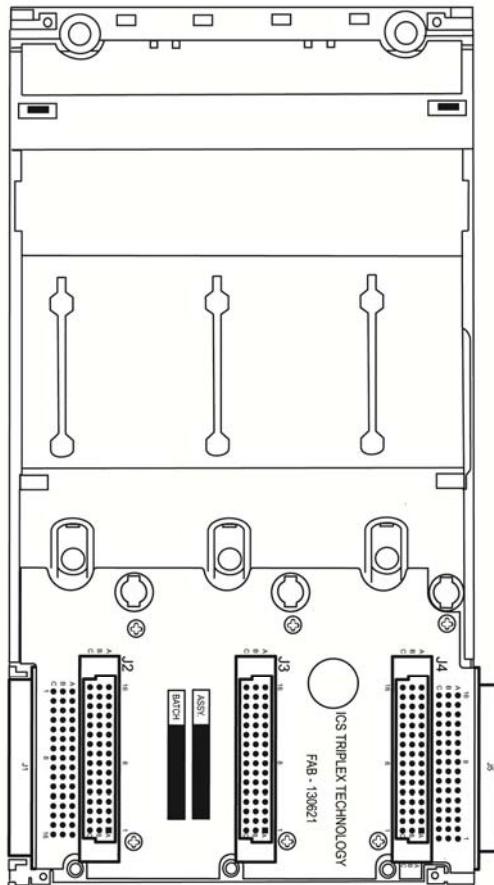
AVERTISSEMENT



Port SK1 pour les modules T9110 et T9111. « Pour la maintenance uniquement lorsqu'installé en environnement dangereux. L'alimentation doit être coupée ou la zone exempte de concentrations de gaz ou de vapeurs inflammables lorsqu'il est utilisé. »

I/O Base Unit

An I/O base unit holds up to three I/O modules:



Termination Assemblies

The AAdvance system provides a range of termination assemblies to connect field wiring to the I/O modules. A termination assembly is a printed circuit equipped with screw terminal blocks for the field wiring (and in some cases fuses) and connectors for the plug-in I/O modules. Termination assemblies give the system designer flexibility when configuring redundant and fault tolerant systems.

Termination assemblies come in three types: simplex, dual or triple to accommodate one two or three I/O modules. Each termination assembly provides connections for up to 16 channels but can accommodate 8 or 16 channel modules.

The version illustrated is a simplex termination assembly for a digital input module. The field wiring connectors are located to the left, the

fuses have a cover (shown open) and the module sockets are to the right. Each fuse cover has a label that identifies the fuse numbers.

Figure 7: Single Termination Assembly

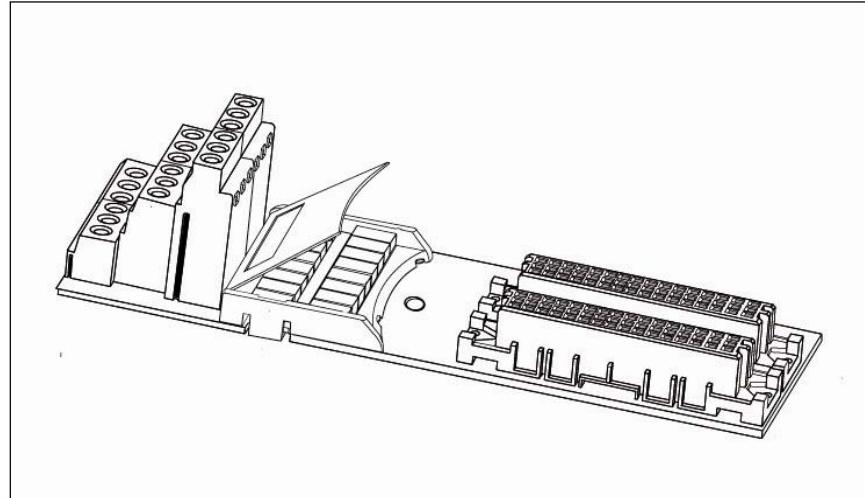
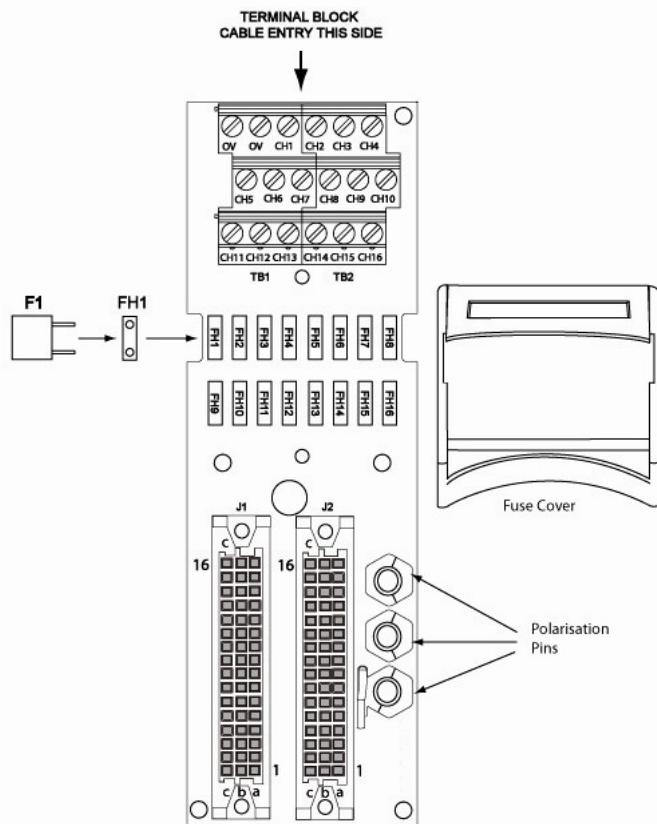


Figure 8: Top View

T9892 Digital Output Termination Assembly

The T9892 Terminal Assembly module operates in conjunction with the T9451 Digital Output Module and provides 8 dual configuration output channels. It shares the same pin-out as the standard AADvance T9852 Digital Output Terminal Assembly and has the same coding peg configuration. The difference is that the T9892 has a separate connector for the field power input voltage connections (the left most terminal block shown below). It also has additional fusing to give extra protection against field faults.

Figure 9: T9892 Dual Termination Assembly

Backplane Electrical Ratings

To comply with UL/CSA standards use the following voltage and current ratings for the Processor and I/O Backplanes when designing your power distribution:

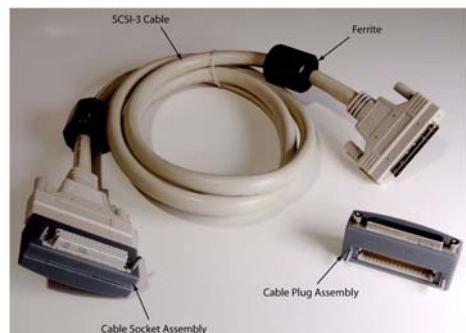
IMPORTANT These are the maximum allowed electrical ratings given by UL for the backplane load installed with the relevant TAs and modules. They are not operating values so don't use them to calculate the controller power consumption or heat dissipation values. Refer to the separate topics on estimating Heat Dissipation and Power Consumption.

Table 5: Maximum Electrical Rating Values

Module	Back-plane Electrical Ratings		Input/Output Electrical Ratings
	Voltage Range (Vdc)	Maximum Current (mA)	
9100	18-32	10.4A (400 mA per slot)	-
9300	18-32	9.6A (400 mA per slot)	-
9110	18-32	380	-
9401	18-32	260	Input: 18-32 Vdc @ 24 mA
9402	18-32	260	Input: 0-32 Vdc @ 6.5 mA
9431	18-32	260	Input: 0-32 Vdc @ 6.5 mA
9432	18-32	260	Input: 18-32 Vdc @ 24 mA
9481	18-32	260	Output: 18-32 Vdc/0-20 mA
9482	18-32	260	Output: 18-32 Vdc/0-20 mA
9451	18-32	165	Output: 18-32 Vdc @ 0.5 A, Pilot duty 16 VA, 1.5 A Inrush
9801	18-32	6.5	-
9802	18-32	6.5	-
9803	18-32	6.5	-
9831	18-32	0-24	-
9832	18-32	0-24	-
9833	18-32	0-24	-
9851	18-32	500	-
9852	18-32	500	-
9892	18-32	500	-
9881	18-32	0-24	-
9882	18-32	0-24	-

Expansion Cable

This is used to add extra rows of I/O base units and modules.



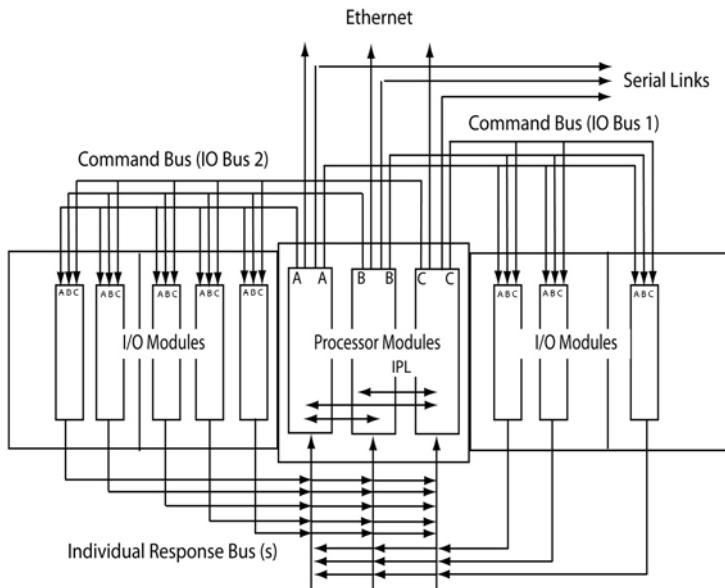
Technical Features

Controller Internal Bus Structure

Internal communication between the processor modules and I/O modules is supported by command and response busses that are routed across the processor and I/O base units.

The processor modules acts like a communications master, sending commands to its I/O modules and processing their returned responses. The two command busses I/O Bus 1 and I/O Bus 2 take the commands from the processor to the I/O modules on a multi-drop basis. An inter-processor link (IPL) supplies the communication links between dual or triple processor modules.

Each I/O module has a dedicated response line which returns to the processor. The unique response line for each I/O module supplies an unambiguous identification of the source of the I/O data and assists with fault containment.



Internal Diagnostics and Fault Reset

The AADvance controller contains comprehensive internal diagnostic systems to identify faults that occur during operation and trigger warnings and status indications. The diagnostic systems run automatically and test the system for faults related to the controller, and field faults related to field I/O circuits. Serious problems are reported immediately, but faults that are not on non-critical items are filtered to prevent spurious alarms. The diagnostic systems monitor such items at regular times, and need a number of occurrences of a possible fault before reporting it as a problem.

The diagnostic systems use simple LED status indications to report a problem. The LED indications identify the module and can also identify the channel where the fault has occurred. There is also a summary system healthy indication for all of the controller. The application software uses its variable structures to report a fault problem; these variables give status reports and are configured using the AADvance Workbench.

Faults in the processor modules are none latching. The controller will recover automatically and the fault indication will clear once the fault condition has been removed. Faults in the I/O modules are latched. To clear them a fault reset signal is sent from the processor module by pressing the **Fault Reset** button on the processor module front panel. Field faults are not latched and will clear as soon as the field fault is repaired.

When the Fault Reset button on each processor module is pressed it attempts to clear a fault indication immediately, however, the diagnostic

systems will report a serious problem again so quickly there will be no visible change in the fault status indications.

Remote Fault Reset

Using the Workbench software you can set up a fault reset variable to mimic pressing the Fault Reset button on the front panel. This feature is provided for systems located in inaccessible locations. Refer to the AAdvance Configuration Guide Doc No: 553633 (555063 for Workbench 2.0) for instructions on how to set up the variable.

On-line updates I/O Configuration Changes

The AAdvance controller modular design makes it easy to create and change the I/O configuration. The on-line update facility enables you to make changes to the I/O configuration after the system is commissioned.

An on-line update can be used for the following changes.

- Expand a system and add new I/O modules, base units and termination assemblies.
- Change the module type in a simplex or group arrangement.
- Expand a simplex or group arrangement.
- Downgrade a group arrangement.
- Move a module to a different slot.
- Change an application variable.

You only have to plug an additional I/O base unit into the side socket on an installed I/O base unit. The command busses on the I/O base units do not need different terminations on the open ends of transmission lines, and the data response busses and power sources are supplied across all I/O base units. Termination assemblies are pushed into the I/O base unit for the additional I/O modules. To put the new modules on-line and make the changes to the system fully operational, the hardware configuration in the AAdvance Workbench software must be updated by an on-line update.

IMPORTANT For Release 1.3 you can change the I/O module configuration with an on-line update. However, if you are using an earlier product release the I/O configuration cannot be changed with an on-line update.

IMPORTANT An on-line update could affect the operation of the controller such that the application is stopped or the I/O data flow is interrupted. The AADvance Safety Manual outlines the precautions you need to follow when doing on-line updates on a Safety System.

When there is not sufficient space for extra I/O base units on a row you can use the Expansion Cable to connect a new row of I/O base units and modules to further expand the I/O system.

Hot Swap I/O for Business Critical Channels

You can add a "hot swap" capability for business critical data channels. By installing a single I/O module into a dual TA. When a dual TA is configured you are leaving an empty spare slot for a replacement I/O module when a fault occurs. You can insert a new I/O module into the spare slot and restore a failed channel without interrupting the operation of the other channels.

TIP Configure this "hot swap" arrangement when you configure your system at installation and set up time.

Processor Firmware Upgrades

You can check the firmware revision of your processor modules without removing them to read the label and you can upgrade the firmware revision of the processor modules. Upgrading the firmware in the 9110 processor module is done in the Recovery Mode and is a two-stage process:

- **Stage 1:** Run the latest version of 350720_xxx_ControlFLASH.msi program to install the ControlFLASH firmware upgrade kit for the Recovery Mode on your PC. Then run the ControlFLASH utility to upgrade your processor module and install the Recovery Mode. If your module is delivered with the Recovery Mode installed then this stage is not necessary.
Stage 1 must be performed individually on each processor; it does not matter if you download the Recovery Mode one at a time in a specific slot or in their own slots.
- **Stage 2:** Reboot the processor and press and hold the Fault Reset button to enter the Recovery Mode. Then run the latest version of 354400_xxxx_ControlFLASH.msi program to install the ControlFLASH to upgrade your processor's OS, FPGA, LSP and BUSP.

When stage 1 is completed ControlFLASH can be used to upgrade three processor modules in the same processor base unit all at the same time.

NOTE	Detailed information and procedures on firmware revision are given in the AADvance Configuration Guide Doc No: 553633 and AADvance Configuration Guide Doc No: 555063 for Workbench 2.0.
-------------	------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Tools and Resources

You will need the ControlFLASH firmware upgrade kit.

- Quick Start and RSLinx Classic Lite software or better.
- ControlFLASH programming tool, along with its required support drivers and on line HELP.
- Firmware for the processor modules being upgraded.

Ethernet Communication Protocols

AADvance Ethernet ports are used to support several transport layer services; these services are listed in the following table:

Protocol	Port Number	Purpose
TCP	502	Modbus Slave
TCP	1132	ISaGRAF, application downloads, debug, SoE
TCP	10001-10006	Transparent Communication Interface (Serial Tunnelling)
TCP	4818	CIP Produce & Consume
TCP	N/A	Telnet (diagnostic Interface)
UDP	1123,1124	IXL Bindings
UDP	2010	Discovery and configuration Protocol
UDP	2222	CIP Produce & Consume I/O
UDP	5000	Trusted peer-to-peer
UDP	44818	CIP Produce & Consume

Page intentionally left blank.

Application (Resource) Development

The AADvance Workbench environment helps you with the task of automation during the life-cycle of your system, from system design to commissioning and the day to day operation and maintenance. For application (resource) development the AADvance Workbench has powerful, intuitive features and functionality to enhance simplicity.

This chapter introduces the AADvance Workbench and describes basic software features.

Programming Language Support

The AADvance Workbench is IEC 61131-3 compliant, offering all five languages of the standard:

- Ladder diagram (graphical)
- Function block diagram (graphical)
- Structured text (textual)
- Instruction list (textual)
- Sequential function chart (graphical)

Note	Instruction List (IL) and Sequential Function Chart (SFC) languages are not supported by AADvance Workbench 2.0.
------	------------------------------------------------------------------------------------------------------------------

Program Management Facilities

The development environment is designed for collaborative working. A group of engineers can work together, with shared ownership of a project. Each contributor can simply look at the part of the application on which they wish to work.

Program management features let you identify each functional module (program organization unit) and its operations, and the interactions between modules to form the complete application. This modular construction can help future use of code units. Engineers can debug their own modules independently from each other.

Programs can be tried and tested on the computer before downloading to the controller hardware.

Support for Variable Types

For each controller, you can declare variables using all types identified in IEC 61131-3, including Boolean, 16-bit integer (signed and unsigned) and 32-bit real. Controller-specific types include structures to hold

multiple variables for each I/O channel type. Variables are easily imported from external databases if required.

Variables are found in a data dictionary. The development environment supplies a hierarchical tree of variables and a grid-like representation of their definitions.

I/O Connection (Addressing of Physical I/O)

To show the links between the hardware-independent logical variables of the AAdvance application program and the physical I/O channel available on the controller, the AAdvance Workbench has a powerful I/O connection editor. I/O channel links are easily identified between the logical programming and the I/O wiring configuration. The I/O configuration can be tested separately from the application execution such that each module can be debugged separately.

Any I/O device can be represented as a single module or a group of redundant modules. Different data types are accommodated. You can work directly on a pre-defined I/O configuration, expand and change the configuration, and the workbench fully supports directly represented I/O variables as described in the IEC 61131-3 standard.

Off-line Simulation and Testing

An engineer can validate a full application off-line, without the target hardware platform. The powerful simulator within the development environment can do structural and functional tests of each module and of the full application.

Application (Resource) Program Security

The AADvance controller includes a Program Enable key that protects the application from access that has not been approved for change. The key must be fitted to the KEY connector on the T9100 processor base unit before you can download and make changes to an application (resource). The program enable key is supplied with the processor base unit and is fitted as shown.



Other security features are available such as password protection at the Workbench and the use of firewall settings

Aids to Software Development

The development environment automatically verifies the syntax of the source code entered in each of its supported languages. It performs checks at each stage of development, correcting or prompting the user with the correct use of the language. There is also extensive on-line help, which includes a cross-referenced explanation of the IEC 61131-3 standard.

Page intentionally left blank.

Before You Begin

This chapter lists important information that should be read before starting to build the system. It covers preparatory information that you should read tasks you should complete for a successful installation.

Required Tools Standard AADvance

The installation and maintenance of the AADvance controller requires the following tools and test equipment:

Standard Tools

- Screwdriver, flat 0.8 mm x 9.0 mm (1/25 inch x 3/8 inch), for the module clamp screws and blanking covers
- Screwdriver, flat 0.6 mm x 3.0 mm (1/40 inch x 1/8 inch), or a similar that will open fuse covers on termination assemblies.
- Screwdriver, cross head number 0, for battery cover on 9110 processor module
- Screwdriver, flat 0.8 mm x 4.0 mm (1/25 inch x 5/32 inch), for screws on extension cables
- Torque screwdriver, flat 0.6 mm x 3.0 mm (1/40 inch x 1/8 inch), for dc power wiring terminals
- Torque screwdriver, flat 0.4 mm x 2.0 mm (1/64 inch x 5/64 inch), for field wiring terminals
- 2 x wrench, open end, 10 mm, for ground stud nuts
- Allen key (hex wrench), 2.5 mm, for plug and sockets assemblies used with extension cables

Special Tools

- Long nosed pliers to remove the fuses on termination assemblies.
- Digital voltmeter, for troubleshooting activities
- Resistor 1k8, for troubleshooting analogue input modules
- Resistor 1k 1W, for troubleshooting digital output modules
- Resistor 250R 1W, for troubleshooting analogue output modules

Specifying an Enclosure

When the system is installed in an enclosure it must meet the UL508 requirements for the installation environment; hold the modules securely, provide mechanical protection and should not interfere with other system components. The enclosure must also be able to handle the heat dissipated by the modules and other components/devices included in the same enclosure.

Maximum Enclosure Air temperature

CAUTION: HEAT DISSIPATION AND ENCLOSURE POSITION

The maximum air temperature rating in an enclosure where standard AADvance processor and I/O modules are installed to ensure predictable reliability is +70 °C (+158 °F) for I/O Modules and +60 °C (+140 °F) for Processor modules. System and field power consumption by modules and termination assemblies is dissipated as heat. You should consider this heat dissipation during the design and positioning of your enclosure; e.g. enclosures exposed to continuous sunlight will have a higher internal temperature that could affect the operating temperature of the modules. Modules operating at the extremes of the temperature band for a continuous period can have a reduced reliability.

ATTENTION: DISSIPATION THERMIQUE ET EMPLACEMENT DE L'ENCEINTE

La température ambiante nominale maximum dans une enceinte où un processeur AADvance et des modules d'E/S standard sont installés pour assurer une fiabilité prévisible, est de +70 °C (+158 °F) pour modules d'E/S et de +60 °C (+140 °F) pour un processeur modules. La consommation électrique du système et du terrain par les modules et les ensembles de raccordement est dissipée sous forme de chaleur. Vous devez tenir compte de l'effet de la dissipation thermique lors de conception et de disposition de votre enceinte, par exemple, des enceintes continuellement exposées à la lumière solaire auront une température interne plus élevée qui pourrait accroître la température de fonctionnement des modules. La fiabilité des modules fonctionnant aux limites extrêmes de la plage de température pendant une période prolongée peut être réduite.

Enclosure Requirements for a Non-hazardous Environment



An AADvance system must be installed in an IP54 enclosure for use in a Pollution Degree 2 environment or similar in accordance with IEC 60664-1: 2007



Un système AADvance doit être installé dans une enceinte normalisée IP 54 si l'environnement est classé en degré de pollution 2 conformément à la norme CEI 60664-1: 2007

Pollution Degree Definition

For the purpose of evaluating creepage distances and clearances, the following four degrees of pollution in the micro-environment are established:

- Pollution Degree 1: No pollution or only dry pollution occurs. The pollution has no influence.
- Pollution Degree 2: Only non-conductive pollution occurs except that occasionally a temporary conductivity caused by condensation is to be expected.
- Pollution Degree 3: Conductive pollution occurs or dry non-conductive pollution occurs which becomes conductive due to condensation which is to be expected.
- Pollution Degree 4: Continuous conductivity occurs due to conductive dust, rain or other wet conditions.

Enclosure Requirements for a Hazardous Environment - Class I, Division 2, Groups A, B, C and D.

The enclosure must comply with the following UL requirements.

Special Conditions for Safe Use

- Models 9110: The ambient temperature range is -25 °C to +60 °C (-13 °F to +140 °F).
 - All other Models: the ambient temperature range is -25 °C to +70 °C (-13 °F to +158 °F).
 - Subject devices are to be installed in an ATEX/IECEx Certified, IP54, tool accessible enclosure that has been evaluated to the requirements of EN 60079-0: 2012 + A11:2013, EN 60079-15: 2010/ IEC 60079 -0 Ed 6 and IEC 60079-15 Ed 4. Enclosure is to be marked with the following: "Warning - Do not open when energized". After installation of subject devices into the enclosure, access to termination compartments shall be dimensioned so that conductors can be readily connected. Grounding conductor should have a minimum cross sectional area of 3.31 mm²
 - Subject devices are for use in an area of not more than pollution degree 2 in accordance with IEC 60664-1.
 - Subject devices are to use conductors with a minimum conductor temperature rating of 85 °C.
 - Subject devices are to be installed in the vertical orientation only.
-

AVERTISSEMENT: Conditions spéciales pour une utilisation sûre

- Modèles 9110: la plage de température ambiante est de -25 °C à +60 °C;
 - Pour tous les autres modèles: la plage de température est de -25 °C à +70 °C;
 - Les dispositifs concernés doivent être installés dans une enceinte certifiée ATEX/CEIEx, IP54, accessible à l'aide d'un outil et qui a été évaluée conforme aux exigences des normes EN 60079-0: 2012 + A11:2013, EN 60079-15: 2010/IEC 60079-0 Ed 6 and IEC 60079-15 ed 4. Le marquage suivant doit être apposé sur l'enceinte : « Avertissement – Ne pas ouvrir sous tension ». Après l'installation des dispositifs concernés dans l'enceinte, l'accès aux compartiments de raccordement sera dimensionné de façon à faciliter le raccordement des conducteurs. Le conducteur de mise à la terre devra avoir une section minimale de 3,31 mm².
 - Les dispositifs concernés sont utilisables dans un environnement présentant un degré de pollution 2 au maximum conformément à la norme CEI 60664-1 ;
 - Les dispositifs concernés doivent utiliser des conducteurs avec une température nominale minimum de +85 °C ;
 - Les dispositifs concernés doivent être installés verticalement uniquement.
-

WARNING - EXPLOSION HAZARD

Do not connect or disconnect equipment while the circuit is live or unless the area is known to be free of ignitable concentrations or equivalent.

AVERTISSEMENT – RISQUE D'EXPLOSION

Ne pas connecter ou déconnecter l'équipement alors qu'il est sous tension, sauf si l'environnement est exempt de concentrations inflammables ou équivalente

WARNING

Substitution of any component may impair suitability for Class I, Division 2 or equivalent.

AVERTISSEMENT

La substitution de composants peut rendre impropre à l'utilisation en Classe I, Division 2 ou équivalente.

CAUTION:

For AADvance modules 9110, 9801, 9803, 9831- 9833, 9851, 9852, 9892, 9881 and 9882 a disconnect suitable for the location where they are installed shall be provided to allow for removal of power from the fuses before replacement.

ATTENTION:

Pour les modules AADvance 9110, 9801, 9803, 9831- 9833, 9851, 9852, 9892, 9881 et 9882, un sectionneur adapté à l'environnement où ils sont installés devra être fourni pour couper l'alimentation en amont des fusibles avant leur remplacement.

Controller Mounting

An AADvance controller and I/O bases can be mounted using one of two methods:

- A pair of parallel TS35 DIN rails.
- Panel mounted using three holes on each base.

Free Space around the Controller

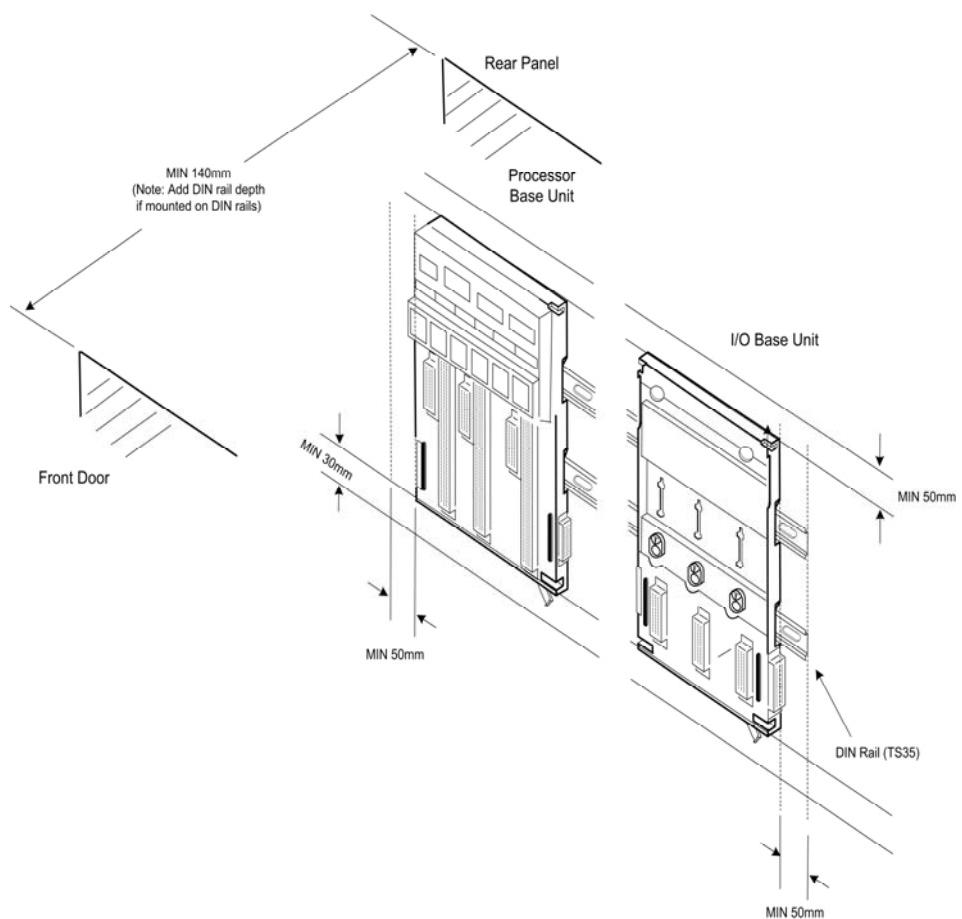
Whichever mounting method is used the minimum depth from the rear mounting panel to the front panel and space around the base units are shown in the illustration, if you wish to mount the controller on DIN rails, increase this allowance by the increased depth of the DIN rails. The DIN rails must be TS35 rail, which is a 35mm × 7.5mm standard symmetric rail.

You must have sufficient free space around the base units to allow for the following:

- Space above, to adjust and install field wiring.
- Space below, to let modules fit and to be able to hold a module during removal.
- Space to the right of the last base unit in the row, to move an I/O base unit during assembly or if you are installing a new base unit.

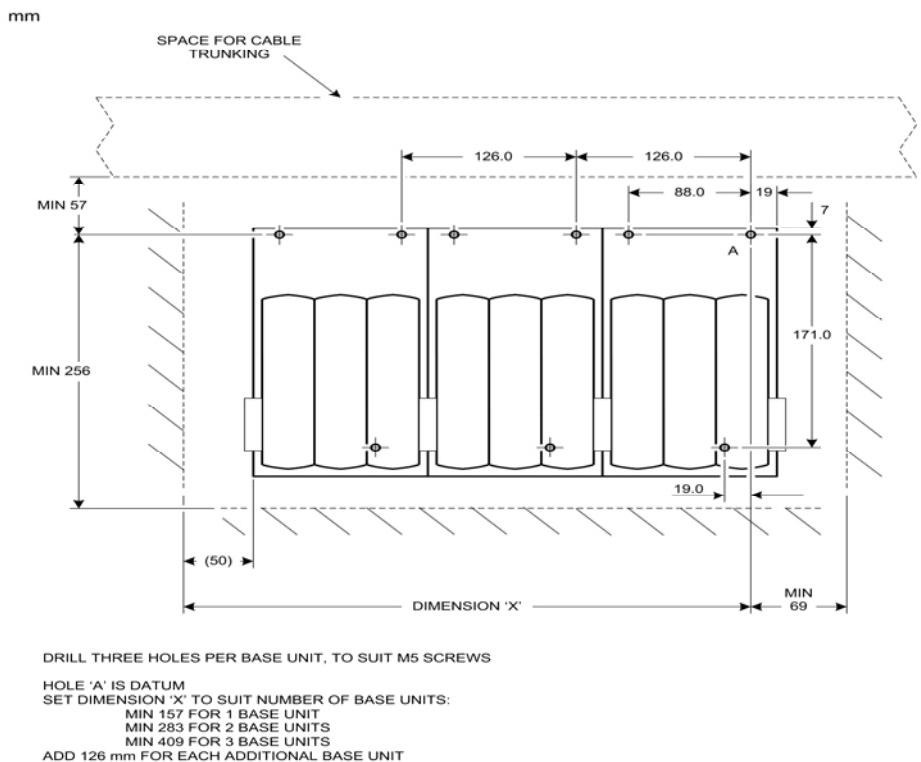
If an expansion cable is to connect to the left-most base unit, the controller also needs space to the left, to fit the expansion cable adapter.

This illustration shows the minimum recommended clearances for a flat panel or DIN rail mounting.



The flat panel drilling holes are shown in the illustration:

Figure 10: Flat Panel Mounting



CAUTION: HEAT DISSIPATION AND ENCLOSURE POSITION



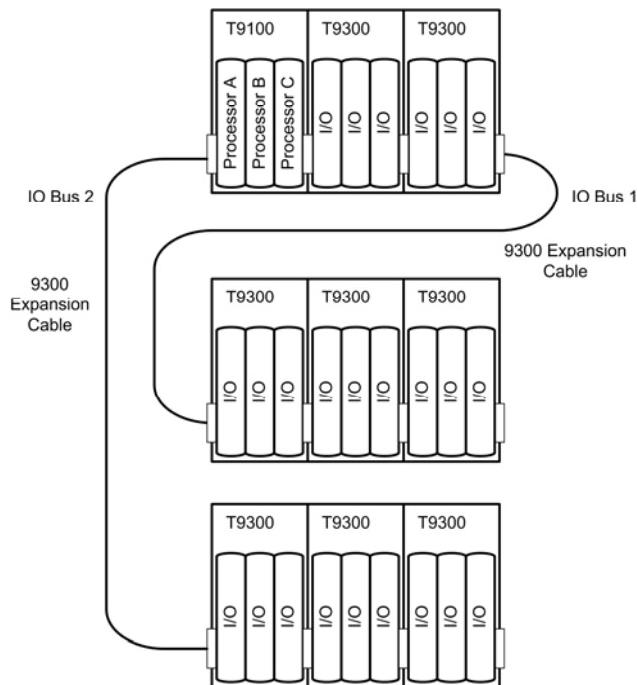
The maximum air temperature rating in an enclosure where standard AADvance processor and I/O modules are installed to ensure predictable reliability is 70 °C (158 °F) for I/O modules and 60 °C (140 °F) for processor modules. System and field power consumption by modules and termination assemblies is dissipated as heat. You should consider the effect of heat dissipation on the design and positioning of your enclosure; e.g. enclosures exposed to continuous sunlight will have a higher internal temperature that could increase the operating temperature of the modules. Modules operating at the extremes of the temperature band for a continuous period can have a reduced reliability.

**ATTENTION: DISSIPATION THERMIQUE ET EMPLACEMENT DE L'ENCEINTE**

La température ambiante nominale maximum dans une enceinte où un processeur AADvance et des modules d'E/S standard sont installés pour assurer une fiabilité prévisible, est de 70 °C (158 °F) pour modules d'E/S et de 60 °C (140 °F) pour processeur. La consommation électrique du système et du terrain par les modules et les ensembles de raccordement est dissipée sous forme de chaleur. Vous devez tenir compte de l'effet de la dissipation thermique lors de conception et de disposition de votre enceinte, par exemple, des enceintes continuellement exposées à la lumière solaire auront une température interne plus élevée qui pourrait accroître la température de fonctionnement des modules. La fiabilité des modules fonctionnant aux limites extrêmes de la plage de température pendant une période prolongée peut être réduite.

Base Units Rows and Expansion Cables

AADvance 9300 I/O base units connect to the right hand side of the 9100 processor base unit (I/O Bus 1) and to the right hand side of other 9300 I/O base units by a direct plug and socket connection. The I/O base units connect to the left hand side of the processor base unit by using the 93100 expansion cable (I/O Bus 2). The expansion cable also connects the right hand side of I/O base units to the left hand side of other I/O base units to install extra rows of I/O base units. Base units are secured in place by top and bottom clips that are inserted into the slots on each base unit.

Figure 11: Connecting Base Units with Expansion Cables

The expansion bus accessed from the right hand edge of the 9100 processor base unit is designated I/O Bus 1, while the bus accessed from the left hand edge is designated I/O Bus 2. The module positions (slots) in the I/O base units are numbered from 01 to 24, the left most position being slot 01. Any individual module position within the controller can thus be uniquely identified by the combination of its bus and slot numbers, for example 1-01.

The electrical characteristics of the I/O bus interface limit the maximum possible length of either of the two I/O buses (the combination of I/O base units and expansion cables) to 8 meters (26.24 ft.).

NOTE The 9310 Expansion Cable is 2 m (6.56 ft.).

Adding Field Cable Management

The field, power and other system wiring will be connected to terminals along the top of the base units. It is recommended a length of cable

trunking or the equivalent be put above each set of base units, for cable management.

Figure 12: Field Wiring Connections



System Power Requirements

A controller's system power should be supplied from two different 24 Vdc (Nominal) power supplies with a common return path; that is, the 0 V return will be the same between the power feeds. Each controller also requires an external field power source for the field loops.



A controller system must be installed with a power network that is designed to meet over voltage Category II (see BS EN 60664-1)

This means that a controller must be supplied with system power from a power source that complies with SELV and PELV standards.

- SELV (safety extra-low voltage) is a voltage which is no larger than 30 Vrms, 42.4 Vpeak and 60 Vdc between conductors, or between each conductor and earth in a circuit which is isolated from the line voltage by a safety transformer.
 - PELV (protected extra-low voltage) is an extra low voltage circuit with a protective partition from other circuits which has a protective earth connection.

To satisfy SELV and PELV requirements the power source must have a safety transformer with a protective partition between the primary and secondary windings so that the windings are galvanic and electrically isolated.

Power Supply and Power Distribution Requirements

The power supplies and power distribution, if incorrectly designed, are a possible electrical or fire safety hazard and can contribute to common cause failure. It is therefore necessary to:

- Establish the power philosophy, specific earthing philosophy, power requirements, and the separation requirements where items of equipment are separately supplied, for example system internal supplies and field loop supplies.
- Make sure that the chosen Power Supply Units (PSUs) are compatible with the power feeds supplied. Alternatively, measures must be put in place to make sure that the power feeds stay within the specifications of the PSUs.
- Define the power distribution requirements, together with the protective philosophy for each distribution; for example, current limited at source or protective devices. Where protective devices are used, it is important to find out that sufficient current will be available to make sure their protective action and the protective device can break the maximum prospective fault current.
- Make sure that the power supplies are sufficient to meet the system load and for any foreseeable load requirements and load transients.
- Make sure that the power supplies have a minimum hold up time of 10ms.
- Make sure that the power distribution cabling is sized to allow the maximum prospective fault currents and tolerable voltage losses. This is specifically important where floating supplies are employed and other power sources can cause high prospective fault currents if multiple earth-faults occur.

Controller Power Supply Requirements

A controller requires the following power supply sources:

- A dual redundant power supply of + 24 Vdc with an operating range of 18 Vdc to 32 Vdc. The AADvance controller is designed to accept supply transient and interference according to IEC 61131 part 2.

An over current fault in the controller must not cause the system to lose power. Consequently, the power sources must be able to supply the peak current to open any over current protection devices (such as fuses) without failing.

The power supply protection of the controller is in the modules, the power distribution arrangement must have a circuit breaker on the input

side of each power source. The controller is designed to be resistant to a reverse polarity connection without permanent damage.

The power sources must come from a commercially available industrial un-interruptible power supply (UPS) system. An applicable UPS must have the capacity sufficient to satisfy the entire system load (including field devices and the controller) and an applicable contingency allowance for projected future expansion.



The power supplies must satisfy the electrical requirements and tests specified in IEC 61131 EN 61010-1 and EN 60950 and must be big enough for the system requirements.

Power Arrangements for Field Devices

Output modules use an external source of power for field devices. This may be the power source used for the controller or a separate power source.

- For digital and analogue outputs a field power supply of +24 Vdc within a range of 18-32 Vdc is required.

Recommended field circuits are given for each type of I/O module later in the section "Connecting Field Wiring".

IMPORTANT It is highly recommended that the negative side of the field supply be connected to earth (ground). This will avoid possible fail danger conditions that can be caused by some earth fault monitors used with floating power supplies.

Power Distribution Protection

The power distribution circuit for each field input and for each output module must be protected, externally to the controller. Rockwell Automation recommend that power distribution must meet national and local panel wiring protection standards.

Digital Output Field Power

Special fusing arrangements are required for Digital Output field supplies for UL, ATEX and IECEx approved installations, (see topic on field loops for Digital Output Modules).

Estimating Power Consumption

To estimate the power supply requirements (power supply sizing) you need to know the power consumption of all the modules. Use the following table to estimate the system power consumption.

Table 6: Module Supply Power Consumption

Item	Number of Modules	Power Consumption	Subtotal (W)
T9110 Processor Module		× 8.0 W	=
T9401 Digital Input Module 24 Vdc, 8 channel		× 3.3 W	=
T9402 Digital Input Module 24 Vdc, 16 channel		× 4.0 W	=
T9431 Analogue Input Module, 8 channel		× 3.3 W	=
T9432 Analogue Input Module, 16 channel		× 4.0 W	=
T9451 Digital Output Module, 24 Vdc, 8 channel		× 3.0 W	=
T9482 Analogue Output Module, 8 channel, isolated		× 3.6 W	=
<hr/>			Total:
<hr/>			

IMPORTANT The above figures are worst case values calculated from the range of operating voltages and currents. If your system is required to meet UL/CSA standards the power consumption and the corresponding electrical ratings must not exceed the maximum electrical ratings given in the table included in the topic "Backplane Electrical Ratings".

Field Power Consumption

To estimate overall controller power dissipation it is necessary to include the field power component dissipated within the controller. Refer to the table "Field Loop Power Heat Dissipation". The field power requirements should be calculated separately and is dependent on the number and type of field elements. Refer to the specifications for the Digital and Analogue output modules for details of the channel output electrical specifications.

System Design Considerations for Heat Dissipation and Cooling

The controller is designed to operate in its specified environment without forced air cooling. However, forced air cooling may be needed in individual circumstances when the controller shares its enclosure with other heat producing equipment and the internal temperature could exceed the recommended operating temperature range.

Module Orientation

Rockwell only recommend that modules are oriented vertically, if modules are mounted in any other orientation then specific temperature tests must be done to ensure reliable and predictable operation.

Maximum Air Temperature

The maximum air temperature rating in an enclosure where AADvance modules are installed to ensure predictable operation is 70 °C (158 °F).

Estimate Heat Dissipation

The heat in the enclosure is generated from several sources such as the power supplies, the AADvance modules and some of the field loop power. Use the following calculation and the data given in the tables to estimate the overall heat dissipation:

- Power supply consumption (Watts x (100-efficacy) (%)) + the sum of the system power consumed by the modules + part of the field power that is in the enclosure.

Table 7: Module Supply Power Heat Dissipation

The following module power dissipation values are worst case values over the range of operating voltages and currents.

Item	Number of Modules	Module Power Heat Dissipation	Subtotal (W/BTU/hr)
T9110 Processor Module		$\times 8.0 \text{ W (27.3 BTU/hr.)}$	=
T9401 Digital Input Module 24 Vdc, 8 channel		$\times 3.3 \text{ W (11.3 BTU/hr.)}$	=
T9402 Digital Input Module 24 Vdc, 16 channel		$\times 4.0 \text{ W (13.6 BTU/hr.)}$	=
T9431 Analogue Input Module, 8 channel		$\times 3.3 \text{ W (11.3 BTU/hr.)}$	=
T9432 Analogue Input Module, 16 channel		$\times 4.0 \text{ W (13.6 BTU/hr.)}$	=
T9451 Digital Output Module, 24 Vdc, 8 channel		$\times 3.0 \text{ W (10.2 BTU/hr.)}$	=
T9482 Analogue Output Module, 8 channel, isolated		$\times 3.6 \text{ W (12.3 BTU/hr.)}$	=
Total:			

Table 8: Field Loop Power Heat Dissipation

The field loop power heat dissipation is generated from the input voltages and currents + the output currents:

Item	Number of Field loops	Field Loop Power Heat Dissipation	Subtotal (W x 3.412 BTU/hr)
Digital Inputs		$\times \text{Input Voltage (V)}/5125$	=
Analogue Inputs		$\times \text{Input current (A)} \times 135$	=
Digital Outputs		$\times \text{Output current (A)} \times 0.57$	=
Analogue outputs		$\times (\text{Field voltage(V)} \times \text{Output Current (A)} - \text{load Resistance}(\Omega) \times \text{Output current (A)})^1$	=
Total:			

¹ The maximum field loop power heat dissipation for analogue outputs should be calculated at an output current corresponding to the smaller of the Maximum Channel Output Current OR Field Voltage/(2 x Load Resistance)

Estimate AADvance Controller Weight

Use the following table to make an estimate of the weight of your controller.

Table 9: AADvance Controller Module Weight

Item	Number Used	Weight Allowance g (oz.)	Subtotal
T9100 Processor Base Unit		× 460 g (16 oz.)	
T9110 Processor Module		× 430 g (15 oz.)	
T9401 Digital input module, 24 Vdc, 8 channel		× 280 g (10 oz.)	
T9402 Digital input module, 24 Vdc, 16 channel		× 340 g (12 oz.)	
T9431 Analogue input module, 8 channel		× 280 g (10 oz.)	
T9432 Analogue input module, 16 channel		× 340 g (12 oz.)	
T9451 Digital output module, 24 Vdc, 8 channel		× 340 g (12 oz.)	
T9482 Analogue output module, 8 channel		× 290 g (10.5 oz.)	
T9300 I/O base unit (3 way)		× 133 g (5 oz.)	
T98x1 Simplex Termination assembly		× 133 g (5 oz.)	
T98x2 Dual Termination Assembly		× 260 g (10 oz.)	
T98x3 Triple Termination Assembly		× 360 g (13 oz.)	
T9310 Expansion cable assembly and 2 m cable		× 670 g (24 oz.)	
T9841 Termination Assemblies (average weight)		× 175 g (6 oz.)	
Total estimated controller weight			

Estimating Center of Gravity Information

If it is necessary to calculate the location of the center of gravity of an AADvance controller destined for a maritime or other shock-mounted application, it is reasonable to assume the center of gravity of each assembly of modules and their base unit is at the geometric center of the assembly.

Design Considerations for Electrical Grounding

All applications of the controller will require at least two separate ground (earth) systems:

- An AC safety ground (sometimes called the 'dirty ground') to protect people in the event of a fault. The ground stud on the T9100 processor base unit, and all exposed metalwork such as DIN rails, will be bonded to the AC safety ground.
- An instrument ground (sometimes called the 'clean ground' or the '0V dc ground') to provide a good stable 0V reference for the

system. Every signal return will be referenced to the instrument ground. The instrument ground will be isolated from the AC safety ground.

The AC safety ground and the instrument ground will usually be made available through bus-bars. Bus-bars must be of copper; they may be nickel plated. For a small application, you may use ground studs instead of bus-bars.

Some field wiring, such as communications cables, will need shielded (screened) cable. There may be a shield ground, in addition to the AC safety and instrument grounds, to provide a common point to terminate shields of such cables. The shield ground will usually be connected to the AC safety ground; or, more rarely, to the instrument ground. In practice, the continuity of the shield connections will be more important than the goodness of the ground connection provided.

The controller input and output modules incorporate galvanic isolation. Nevertheless, it is possible that a particular application will require the provision of barrier strips with galvanic isolation, for example to provide consistency with an existing installation. In these cases, there may be a separate intrinsic safety ground as well.

Specifying the Workstation PC

The minimum workstation requirements for the application development software are as follows:

- A PC running:
- Operating system (32- or 64-bit):
- Microsoft Windows XP Service Pack 3



CAUTION: Do not use XP Professional x64 Edition

- Windows Vista
- Windows 7
- Microsoft Windows Server 2003
- Microsoft Windows Server 2008

IMPORTANT For Workbench 1.3 Network Licensing - Windows 64-bit version will only work with the USB license key and will not recognize a Workbench software license key.

Hardware:

- 1.6 GHz CPU
- 1 GB RAM (32-bit) or 2 GB RAM (64-bit) (add 512 MB if running in a virtual machine)
- DirectX 9 capable video card running at 1024 x 768 resolution display
- 5,400 RPM hard disk
- 3 GB available hard disk space
- DVD drive or network connection, to read software distribution files

NOTE

If the application is Workbench 1.3 and adopts the USB dongle licensing option the workstation PC will require one free USB port.

- Network port (10/100 Base T Ethernet), for communications with the controller

It is recommended that the PC has a 2.2 GHz or higher CPU; 1,024 MB or more RAM, a 1,280 x 1,024 display and a 7,200 RPM or higher hard disk.

It is also recommended that the hard disk has at least 10 GB free space. This provides sufficient space to hold the distribution zip file, the unzipped source files and the installed program files, and also enough space for Windows to operate reasonably quickly. You can get back a lot of this space by deleting the source files after finishing the installation.

Design Considerations for Maintenance Activities

Maintenance Activities

The design of the installation must allow preventive and corrective maintenance activities to take place. Corrective maintenance tasks will embrace the identification and renewal of defective modules and other assemblies and, when exhausted, renewal of the back-up battery within the T9110 processor module.

Fuses on the termination assemblies can be replaced so access to the fuses is required. There are no user-serviceable parts inside modules therefore repair is by replacement; defective modules should be returned to Rockwell Automation for investigation and repair.

WARNING: EXPLOSION HAZARD

Do not connect or disconnect equipment, while the circuit is live or unless the area is known to be free of ignitable concentrations or equivalent.

AVERTISSEMENT – RISQUE D'EXPLOSION

Ne pas connecter ou déconnecter l'équipement alors qu'il est sous tension, sauf si l'environnement est exempt de concentrations inflammables ou équivalente.

Design Provisions

The design of the controller installation should make the following provisions:

- Clear access to remove and install modules, termination assemblies, base units and security dongle (Program Enable key). Repair of controller modules will be by module replacement.

A way for plant operations personnel to inspect the status LEDs on each module. The status LEDs report faults.



Clear access to examine, remove and install fuses located on the termination assemblies.



Clear access to terminals and connectors for field, power and network wiring, and access to the wiring itself.



Clear access to the Security Dongle (Program Enable Key)



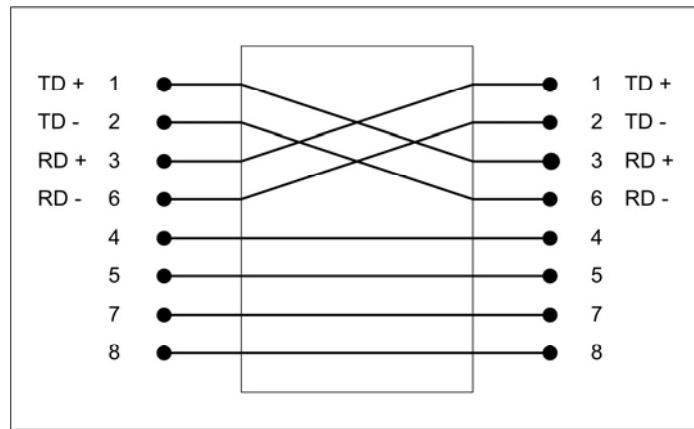
In addition, it may be appropriate to make the following provisions:

- A lock on the door of the enclosure, to deter unauthorized access and possible unofficial modifications.
- Lighting.
- Utility sockets.

Connecting the AADvance Controller to the Network

The T9100 processor base unit has six auto-sensing 10/100BASE-TX Ethernet ports which allow it to connect to a local area network through standard Rj45 Ethernet cable. These are two ports for each processor module.

If a direct connection is required from the controller to the workstation PC (for example during setting up) use a crossover cable. This will depend on the characteristics of the network interface in the PC.

Wiring for 100BASE-TX Ethernet Crossover Cable

The fixed connectors on the controller are RJ45 sockets. Use Cat5e (enhanced) cables with RJ45 modular plugs for the network cabling.

Connect the network cables to the sockets on the T9100 processor base unit.

- For each network connection, insert the RJ45 modular plug on the cable into the appropriate socket.
- Make sure the length of the cable does not exceed 100m (328 ft).

Refer to the illustration for an example.



Install the AADvance System

The system installation defines the steps that will ensure the system is correctly installed and ready for the on-site factory tests before the system is brought on-line. This chapter describes how to install the AADvance system hardware into the chosen enclosure.



In addition to the installation guidelines given in this chapter you must also use installation and commissioning procedures that obey the rules and standards of the country of installation. These standards can include for example, IEC 61511, NFPA72 and ISA 84.00.01 depending on the location.

Unpacking and Pre-assembly Checks

The components are packed to make sure they arrive undamaged and ready for assembly. Nevertheless, you should inspect all modules before beginning the assembly work.

On receipt, carefully inspect all the shipping cartons for damage.

- If any cartons are damaged, note the damage on the carrier's shipping document before signing it. Save any damaged cartons for inspection by the carrier.
- If any part of the delivered components has been damaged during shipping, notify the carrier and Rockwell Automation immediately.

Damaged goods must be returned Rockwell Automation for repair or replacement (see Warranty and Returns instructions with delivery documentation).



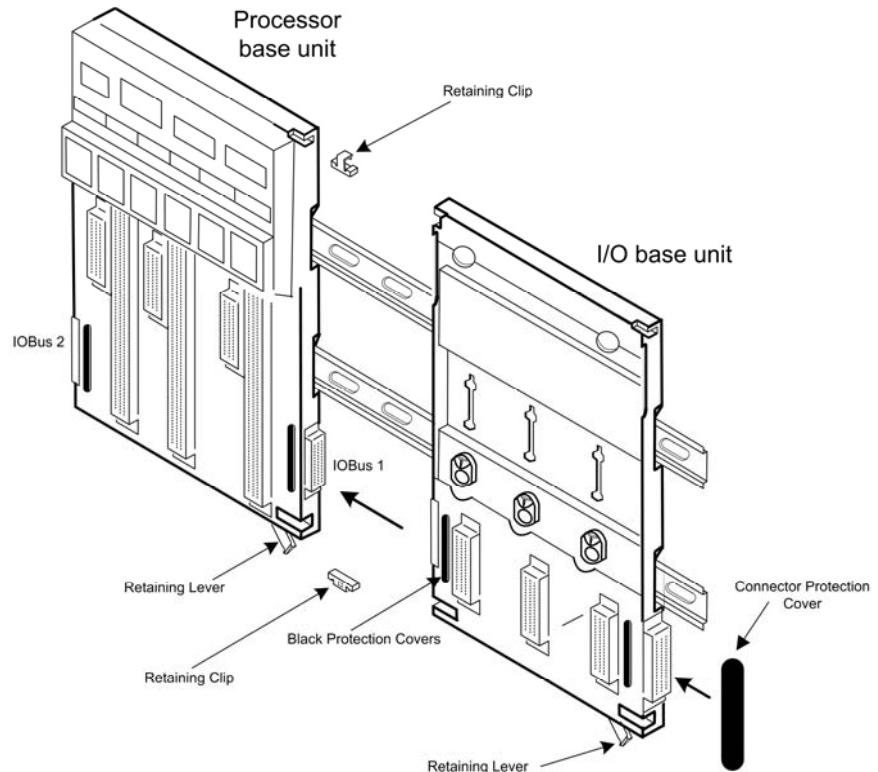
CAUTION: Handling Modules Stored at Extreme Temperatures:

It is recommended that modules removed from storage should be allowed to normalize their temperature before installation. This is particularly important when modules have been stored at very low temperatures where condensation can occur. Remove the modules and place them in an upright position and wipe away any condensation that might appear on the modules. Failure to follow these recommendations could lead to damage to modules or incorrect operation when installed into a running system.

Install Base Units and Termination Assemblies: Enclosure DIN Rail Assembly Method

The following illustration shows how to fit the backplanes onto DIN rails and use the retaining clips and lever to hold them in position.

Figure 13: Fit I/O Base Unit onto DIN Rails



IMPORTANT Fit the rubber connector protection cover to exposed connectors that are not joined to another base unit.

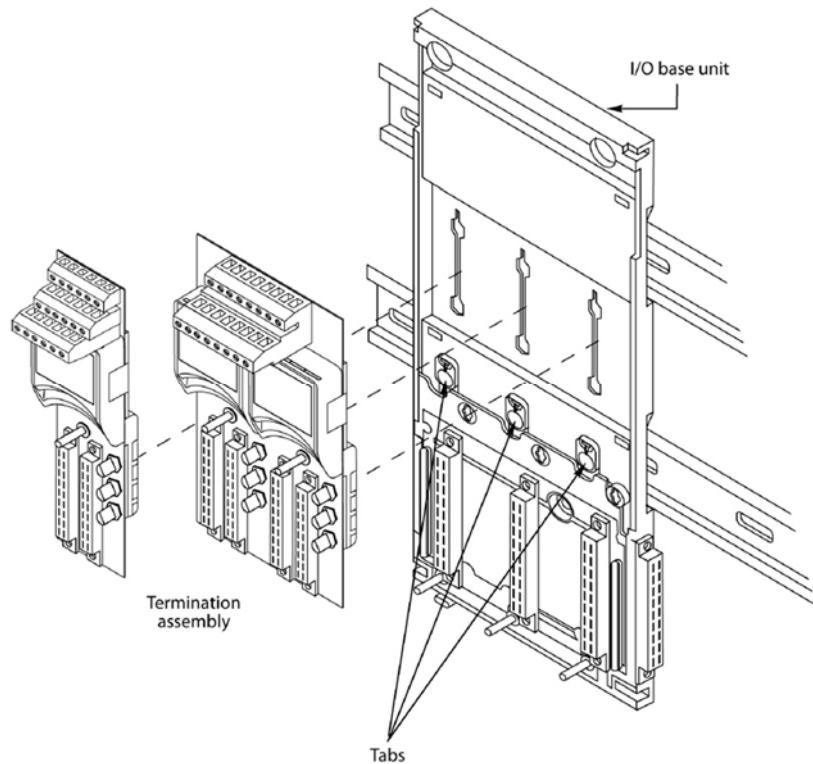
For a system build that uses DIN rails do the following:

1. Install the DIN rails.
 - The AADvance controller will be mounted onto one or more pairs of parallel DIN rails. For each pair of rails, mount the lower rail with its center line 101.0mm below the center line of the upper rail. M5 thread rolling screws are suitable.
2. Mount the T9100 processor base unit
 - Place the T9100 processor base unit onto the DIN rails and position it towards the left, leaving space for the T9300 I/O base units to the right.

- Secure the processor base unit onto the DIN rails by sliding the retaining lever (below the base unit) to the left.
3. Mount each T9300 I/O base unit
- Place a T9300 I/O base unit onto the DIN rails to the right of the T9100 processor base unit.
 - Slide the I/O base unit to the left until the joining connectors are fully mated.
 - Insert the retaining clips at the top and bottom of the base units.
 - Secure the I/O base unit onto the DIN rails by sliding the retaining lever (below the base unit) to the left. Then insert the backplane clips into the top and the bottom slots.
4. Mount end stops onto DIN rails.
- Install two end stops onto the upper DIN rail, one at each end of the assembly.

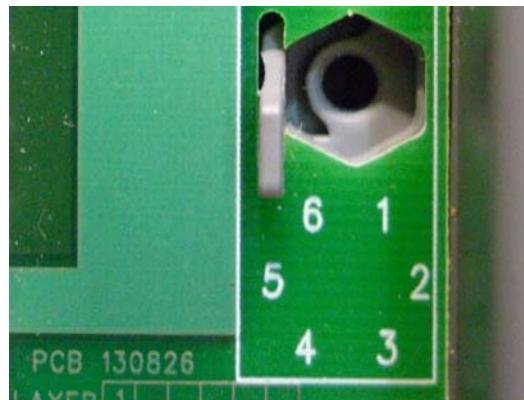
Fitting Termination Assemblies

Figure 14: How to Fit Termination Assemblies

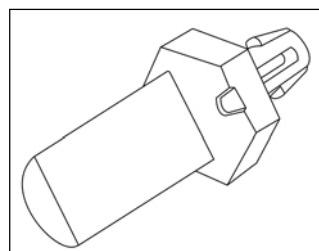


1. To fit termination assemblies do the following:
 - Insert the retaining clip on the back of the termination assembly into the slot on the I/O base unit. Press the termination assembly onto the base unit and then slide the assembly upwards as far as it will go.
 - Make sure the retaining tab clips over the printed circuit board to secure the termination assembly in position.
2. Check coding pegs.
 - Observe the legend on the 9100 processor base unit (and repeated on some termination assemblies) which defines the six

possible positions for a coding peg. The positions are numbered from 1 to 6.



- Examine a coding peg (fitted) and identify the index recess on the hexagonal flange.



- Refer to the following table and verify each coding peg is fitted so its index recess is adjacent to the relevant numbered position.

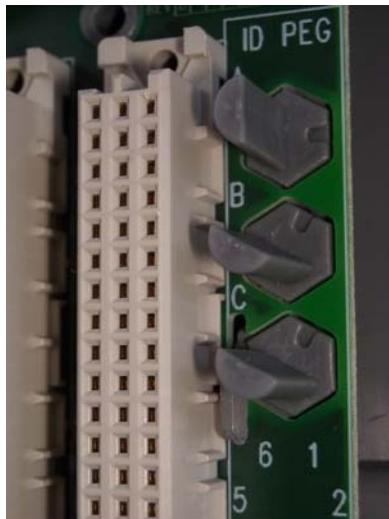
Allocations of Coding Pegs

Coding pegs are assigned to each module type as shown in the following table:

Application	Key A	Key B	Key C
9100 processor base unit (for 9110 processor module)	1	1	1
9801/2/3 digital input termination assemblies (for digital input modules)	2	1	1
9831/2/3 analogue input termination assemblies (for analogue input modules)	2	1	3

9851/2 digital output termination assemblies (for digital output modules)	3	1	1
9842/1 analogue output module	3	1	2

This example shows pins set to positions 2, 1, 1 for a 9401 digital input module.



Mount the Power Supply Units

1. Mount power supply units onto the DIN rails.
 - To install the power supply units, refer to the manufacturers' instructions supplied with the units.

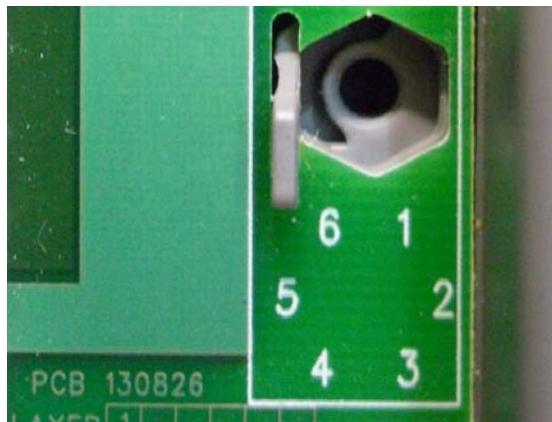
Install Base Units and Termination Assemblies: Flat Panel Assembly

Flat panel assembly secures the AADvance controller directly onto a panel, without the use of DIN rails. Do the following:

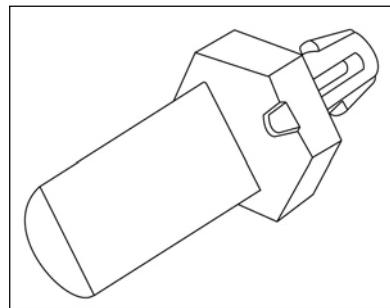
NOTE	Remove the black protection covers when joining base units together.
-------------	----------------------------------------------------------------------

1. The base units carry latches which are intended to secure the base units to DIN rails.
2. Assemble the base units. Place the base units on a workbench and use the backplane clips (supplied) to join adjacent base units together.
 - Use only finger pressure to manipulate and engage the clips. Do not attempt to use a screwdriver or other tool as injury or equipment damage may result.

- Use two clips for each join.
3. Mark off the panel to locate hole positions for three screws for each base unit. You can place the assembly of base units onto the panel and use the assembly as a template, or refer to the illustration to locate the holes.
- Mark and drill the panel and then secure the base units. M5 screws are suitable.
4. Mount power supply units.
- To install the power supply units, refer to the instructions supplied with the units.
5. Fit termination assemblies.
- Insert the retaining clip on the back of the termination assembly into the slot on the I/O base unit. Press the termination assembly onto the base unit and then slide the assembly upwards as far as it will go.
 - Make sure the retaining tab clips over the printed circuit board to secure the termination assembly in position.
6. Check coding pegs.
- Observe the legend on the 9100 processor base unit (and repeated on some termination assemblies) which defines the six possible positions for a coding peg. The positions are numbered from 1 to 6.



- Examine a coding peg (fitted) and identify the index recess on the hexagonal flange.



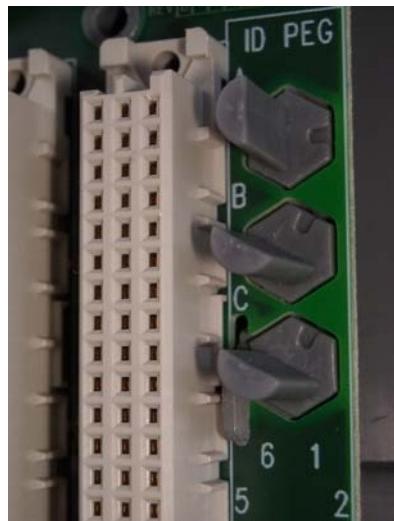
- Refer to the following table and verify each coding peg is fitted so its index recess is adjacent to the relevant numbered position.

Allocations of Coding Pegs

Coding pegs are assigned to each module type as shown in the following table:

Application	Key A	Key B	Key C
9100 processor base unit (for 9110 processor module)	1	1	1
9801/2/3 digital input termination assemblies (for digital input modules)	2	1	1
9831/2/3 analogue input termination assemblies (for analogue input modules)	2	1	3
9851/2 digital output termination assemblies (for digital output modules)	3	1	1
9842/1 analogue output module	3	1	2

This example shows pins set to positions 2, 1, 1 for a 9401 digital input module.



Connect the AC Safety Ground Connection

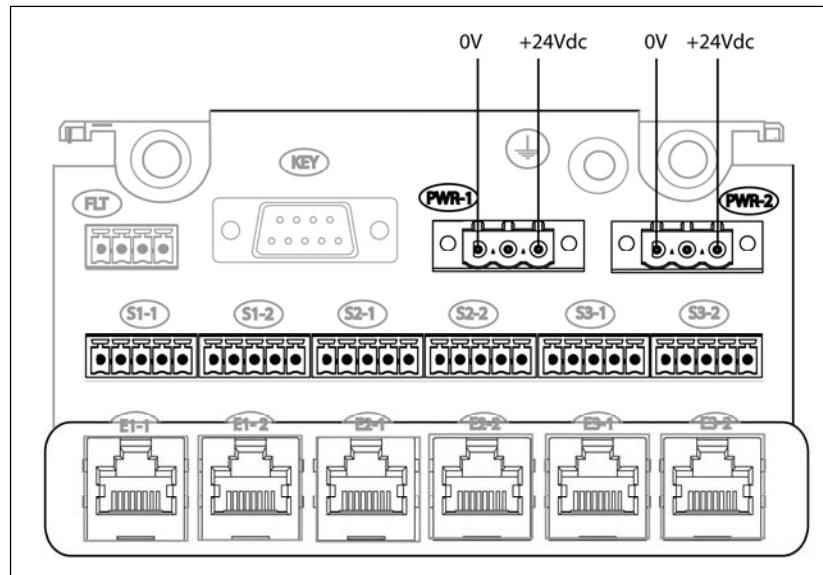
The T9100 processor base unit has a ground stud which must be connected to the AC safety ground. Connect the ground stud to the AC safety ground bus-bar of the system or panel.

- Conductor wire must be a minimum of 12 AWG (3.31 mm^2) with a temperature rating of 85 °C.
- Use a M6 lug on the end of the ground wire.
- Place the lug below the second nut on the ground stud, between two washers, and use two 10mm wrenches to tighten the nuts to a torque of 1.2 Nm to 2 Nm (0.88 lb./ft. to 1.48 lb./ft.).

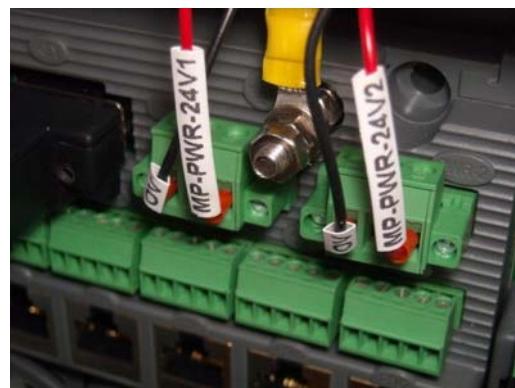
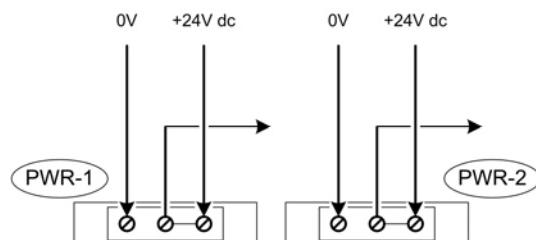
Refer to the photograph of the 24 V dc power connectors the earth stud is shown between the two power leads.

Connect the 24 V dc System Power to an AADvance Controller

The dual redundant +24 Vdc system power, taken from the chosen power source, is connected to the controller at two plugs labeled PWR-1 and PWR-2 on the processor base unit:



The processor base unit has a link between the +24 Vdc connections to the center terminal of each connector PWR-1 and PWR-2. This link may be useful to connect the +24 Vdc supply to further devices:



For each power supply connection, do the following:

- Connect the negative line from the power supply, typically labeled '0 V', to the left-hand terminal.
- Connect the positive line from the power supply, typically labeled '+24 V', to the right-hand terminal.
- Apply a minimum tightening torque of 0.5 Nm (0.37 ft. lb.) to the terminal screws.

IMPORTANT Make sure that PWR-1 and PWR-2 are supplied from independent 24 Vdc sources.

Procedure to Connect Serial Communications Cabling

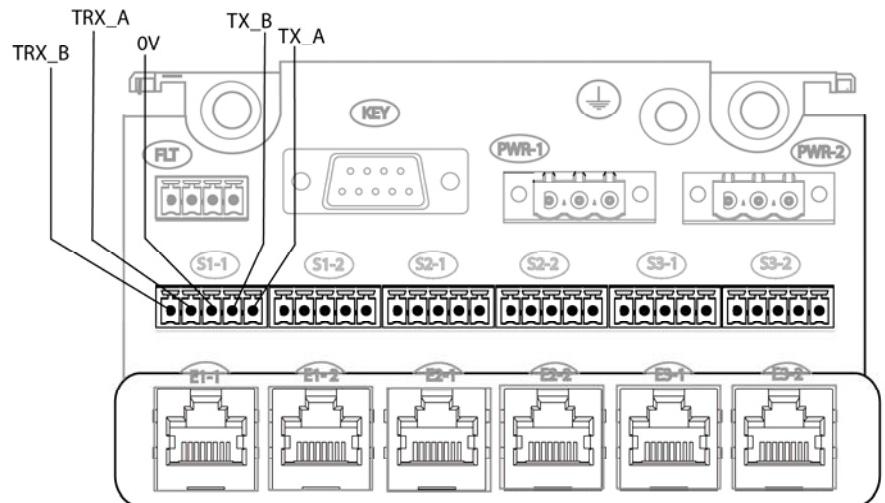
The serial ports (S1-1 and S1-2; S2-1 and S2-2; S3-1 and S3-2) support the following signal modes depending on use:

- RS485fd: A four-wire full duplex connection that features different busses for transmit and receive. This selection must also be used when the controller is acting as a Modbus master using the optional four-wire definition specified in Section 3.3.3 of the Modbus-over-serial standard.
- RS485fdmux: A four-wire full-duplex connection with tri-state outputs on the transmit connections. This must be used when the controller is acting as a Modbus slave on a four-wire bus.
- RS485hdmux: A two-wire half duplex connection applicable for master slave or slave use. This is shown in the Modbus-over-serial standard.

Each processor uses the two serial ports above it on the baseplate. Data is not mirrored between ports. Therefore a single processor system has two ports available, a dual processor system has four ports and a triple processor system has six ports available to it.

Connect the serial communications cabling to the six plugs labeled S1-1 through S3-2 on the T9100 processor base unit.

- For each serial communications connection, connect the cabling according to the following illustration.
- Apply a minimum tightening torque of 0.22 Nm (0.16 ft. lb.) to the terminal screws.
- Make sure the length of the cable does not exceed 1,200 m (3,900 ft.).



Terminal	Function Description (4-wire) ¹	Function Description (2-wire) ¹
TRX_A	Receive data A (inverting)	Transmit/receive data A (inverting)
TRX_B	Receive data B (non-inverting)	Transmit/receive data B (non-inverting)
OV	Instrument ground (signal ground)	Instrument ground
TX_B	Transmit data B (non-inverting)	not used
TX_A	Transmit data A (inverting)	not used

¹ The line functions shown in the table ("receive" and "transmit") are with respect to the processor base unit.

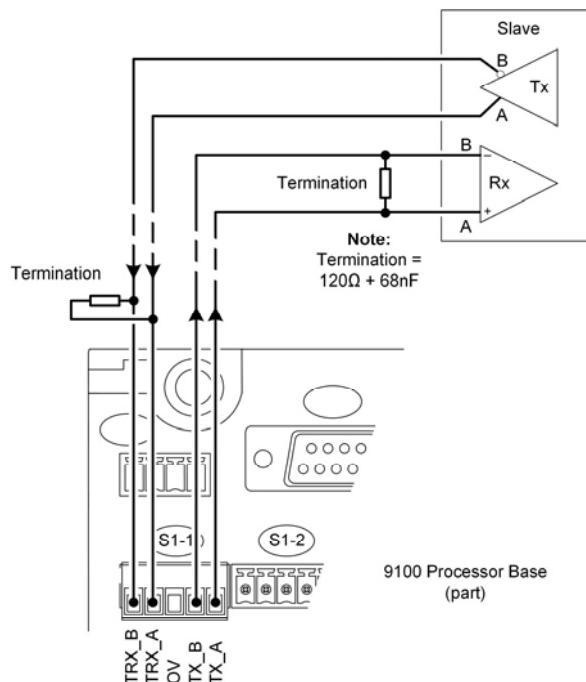
NOTE	To connect to the external communication link you should terminate the receive end of the twisted pairs with a 120 Ω resistor in series with a 68nF capacitor at the receiver ends.
-------------	-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Connecting Modbus Slave Devices to Serial Ports

You can use a full duplex or a half-duplex connection for a Modbus slave device on a serial port.

Connect a Slave Device, Full Duplex

You can use a full duplex serial connection to connect one Modbus slave device to the AAdvance controller. To make the physical connection, do the following:



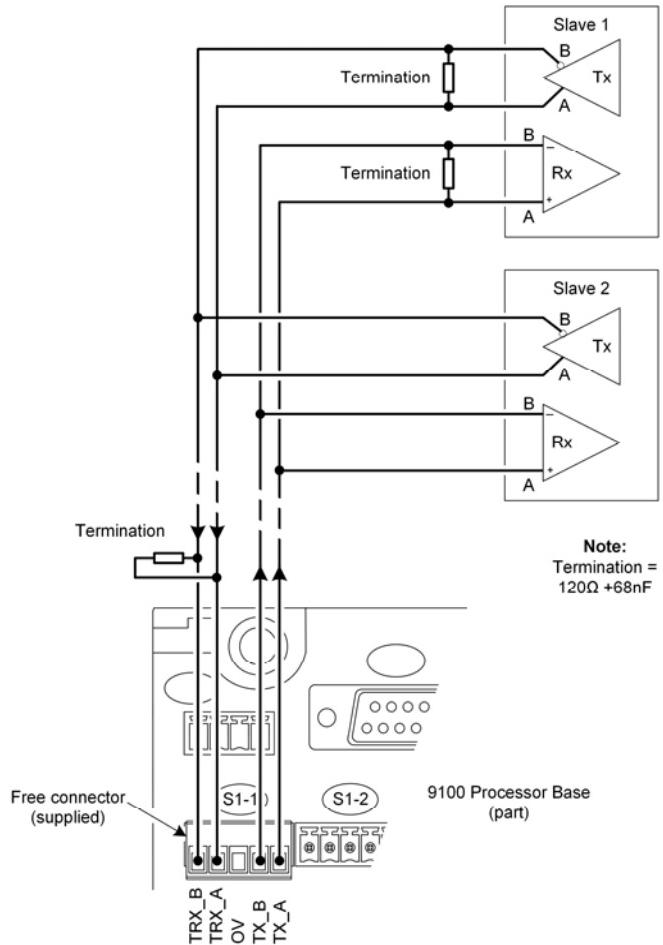
1. Select an applicable cable. We recommend 3-pair, overall shielded cable.
2. Remove the serial port connector from the 9100 processor base unit.
3. Make the connections shown in the illustration. Terminate the twisted pairs with a 120Ω resistor in series with a 68nF capacitor at the receiver ends.
4. Connect the signal ground (not illustrated) from the 0 V terminal to the slave device.

IMPORTANT Do not connect the signal ground to the AC safety ground.

5. Insert the connector into the 9100 processor base unit.

Connect Multiple Slave Devices, Full Duplex

You can use a full duplex serial connection to connect multiple Modbus slave devices to the AADvance controller. To make the physical connection, do the following:



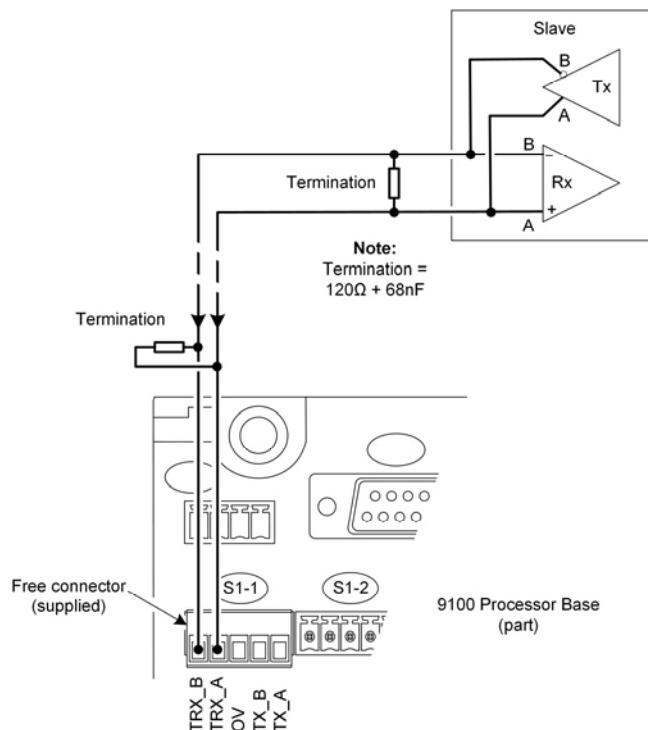
1. Select an applicable cable. We recommend 3-pair, overall shielded cable.
2. Remove the serial port connector from the 9100 processor base unit.
3. Make the connections shown in the illustration. Terminate the twisted pairs with a 120Ω resistor in series with a 68nF capacitor at the locations shown.
4. Connect the signal ground (not illustrated) from the 0 V terminal to each slave device.

IMPORTANT Do not connect the signal ground to the AC safety ground.

5. Insert the connector into the 9100 processor base unit.

Connect a Slave Device, Half Duplex

You can use a half duplex serial connection to connect a single Modbus slave device to the AADvance controller. To make the physical connection, do the following:



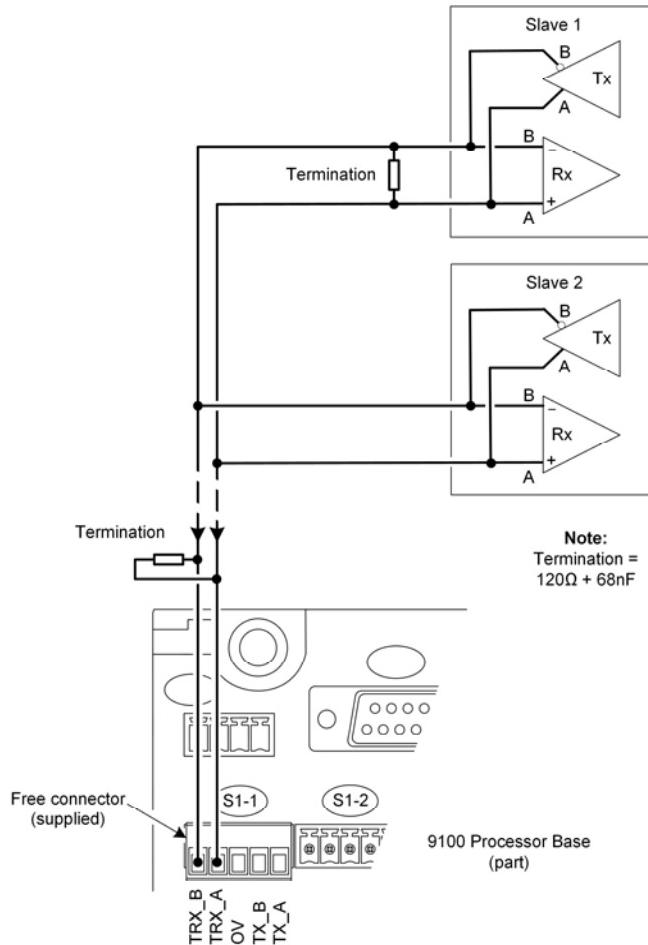
1. Select an applicable cable. We recommend 2-pair, overall shielded cable.
2. Remove the serial port connector from the 9100 processor base unit.
3. Make the connections shown in the illustration. Terminate the twisted pair with a 120Ω resistor in series with a 68 nF capacitor at the two ends.
4. Connect the signal ground (not illustrated) from the 0 V terminal to the slave device.

IMPORTANT Do not connect the signal ground to the AC safety ground.

- Insert the connector into the 9100 processor base unit.

Connect Multiple Slave Devices, Half Duplex

You can use a half duplex serial connection to connect multiple Modbus slave devices to the AADvance controller. To make the physical connection, do the following:



- Select an applicable cable. We recommend 2-pair, overall shielded cable.
- Remove the serial port connector from the 9100 processor base unit.
- Make the connections shown in the illustration. Terminate the twisted pair at the two ends with a 120Ω resistor in series with a $68nF$ capacitor.

-
4. Connect the signal ground (not illustrated) from the 0 V terminal to each slave device.

IMPORTANT	Do not connect the signal ground to the AC safety ground.
------------------	-----------------------------------------------------------

5. Insert the connector into the 9100 processor base unit.

System Security

Serial networks are closed and local and have limited protocol functionality, so they are immune to any external attack apart from local deliberate sabotage. The AADvance system, however, with its workstations and DCS interfaces, uses Ethernet networks which are frequently part of a larger corporate network and can expose the system to accidental or malicious infection or attack.

These steps help prevent such issues:

- Network and workstation security must be used when installing and setting up the system. As a minimum set up the following security measures:
 - AADvance must not be on a network with open unsecured access to the Internet.
 - The Firewall must be active on the Workstation, preventing access to the relevant Ethernet ports on each communication interface. Anti-virus software must be installed and be kept updated.

IMPORTANT	Firewalls have been known to change the operation of the AADvance Discover tool.
------------------	----------------------------------------------------------------------------------

- The workstation must be password protected. If the workstation is a laptop, it must be kept locked when not in use.
- If the workstation uses a hardware license USB dongle it must be kept secure, without it the workstation will not run.
- The application must be password protected.
- Removable media, such as USB storage devices and CDs, must be virus checked before use in the system.

Connecting Field Wiring

Connect the field wiring to the screw terminal blocks on the termination assemblies.

Use conductor wire with a cross section of 16 AWG. The stripping length should be 6mm (1/4 in.) and a conductor temperature rating of 85 °C. Apply a tightening torque of 0.5 Nm (0.37 ft. lb.) to the terminal screws.

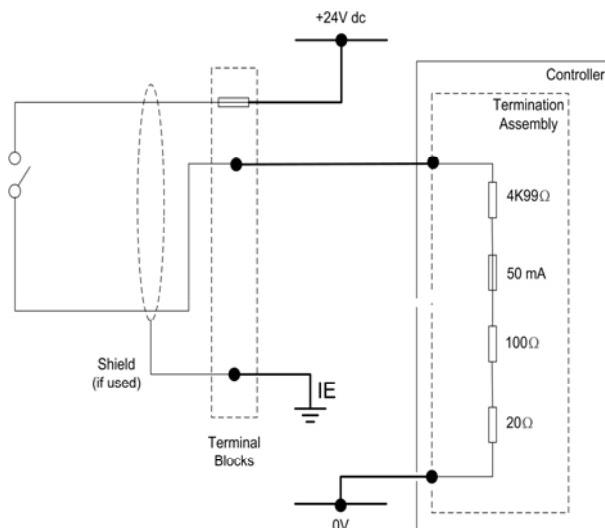


Digital Input Field Loop Circuits

Recommended Field Loop Circuits

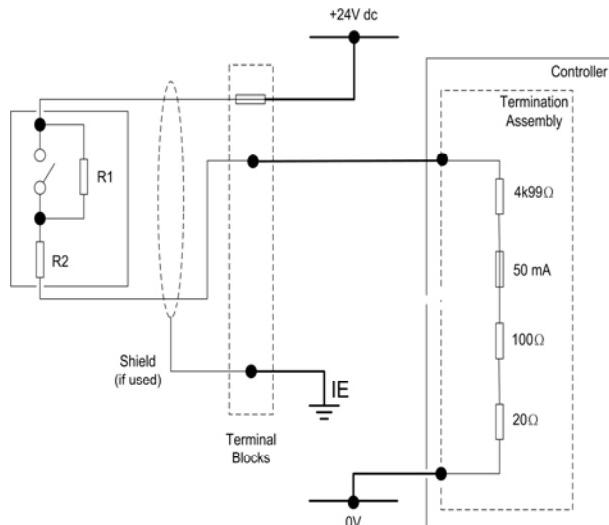
This section contains recommended field loop circuits for line monitoring digital inputs used in Emergency Shutdown or Fire & Gas applications.

Field Loop Circuit for Digital Input



Where IE = Independent earth

Field Loop Circuit for Line Monitored Digital Input for Emergency Shutdown Systems (ESD)



The suggested values for R1 and R2 are as follows:

- $R1 = 15K \Omega$ 1%, 1W (maximum power dissipated is 47 mW at 26.4 V)
- $R2 = 3K9 \Omega$ 1%, 1W (maximum power dissipated is 182 mW at 26.4 V)

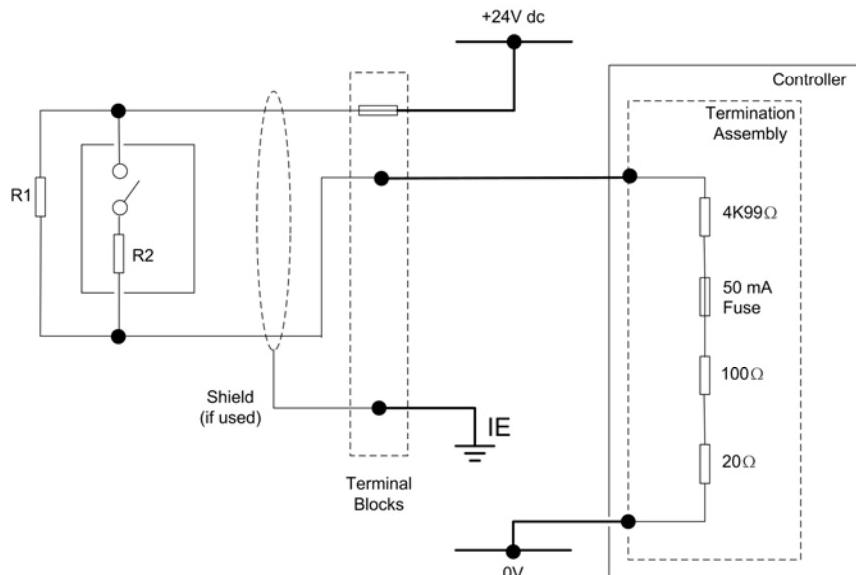
Suggested threshold values for the ESD line monitoring circuits are as follows:

Threshold ID	=	Value (mV)
Maximum Allowed	=	32000
SHORT CIRCUIT		
Threshold 8	=	19000
Threshold 7	=	18500
ON (nominal 16V)		
Threshold 6	=	11000
Threshold 5	=	10500
INDETERMINATE		
Threshold 4	=	6500

Threshold 3	=	6000
OFF (nominal 8V)		
Threshold 2	=	3500
Threshold 1	=	3000
OPEN CIRCUIT		

Assumptions:

- Loop supply voltage = $24\text{ V} \pm 10\%$
- Maximum Field Cable Line Resistance: $< 100\Omega$ total; this means $< 50 + 50\Omega$ for the two cables.
- Minimum Isolation is $0.75\text{M}\Omega$ between the field loop conductors.
- These values will let the input find more accurately different voltage levels that represent OPEN CCT - OFF - ON - SHORT CCT and will also identify Over Voltage and an input which is not ON or OFF. The values make sure that a line fault will be declared before it becomes possible for a false declaration of ON and OFF states because of a combination of resistor value drift and loop voltage variation.

Field Loop Circuit for Line Monitored Digital Input for Fire and Gas Systems (F&G)

- The F&G circuit will also permit two devices to be in alarm without reporting short circuit.

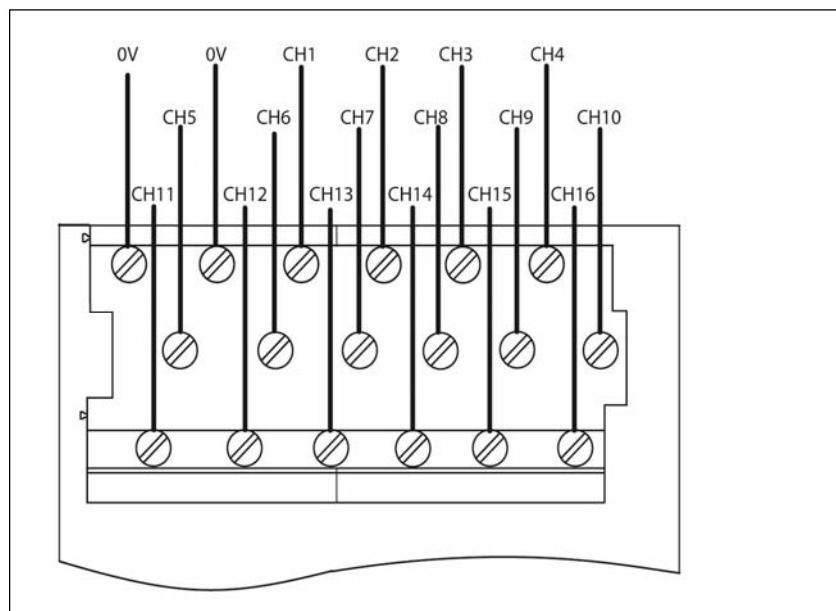
- All of the input circuits are applicable for simplex, dual and TMR configurations.
- The F&G circuit assumes that the devices are volt-free contacts.
- For more information, please refer to Application Note AN-T90001 Field Loop Configuration. This also includes advice for fire detectors which are not simple volt free contacts.

Digital Input SlewTolerance

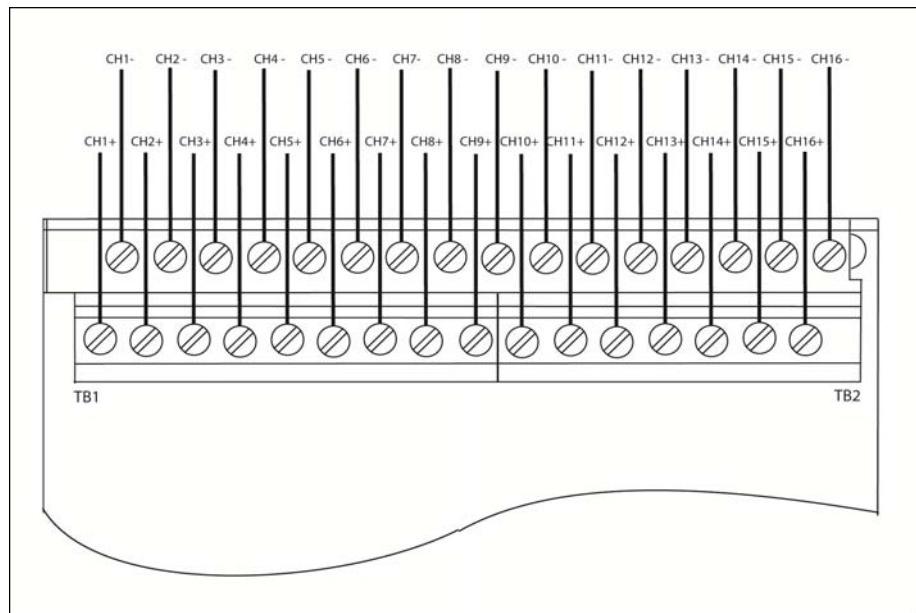
It is possible during sustained periods of abnormal input voltage slewing that channels can be declared faulted as a consequence of diagnostics otherwise designed to ensure the channels are operating within their designed safety accuracy.

To avoid spurious declaration of channel faults it is necessary to ensure that the input signal condition satisfies the maximum slew rate criteria defined in the Solutions Handbook. Accordingly it may be necessary to condition the input signal such as by filtering or by appropriate choice of process safety time.

Connections to 9801 Non-isolated Digital Input TA — 16 Channel Simplex



- Apply a minimum tightening torque of 0.5 Nm (0.37 ft. lb.) to the terminal screws.

Connections to 9802/9803 Isolated Digital Input TA — 16 Channel Dual/TMR

- Apply a minimum tightening torque of 0.5 Nm (0.37 ft. lb.) to the terminal screws.

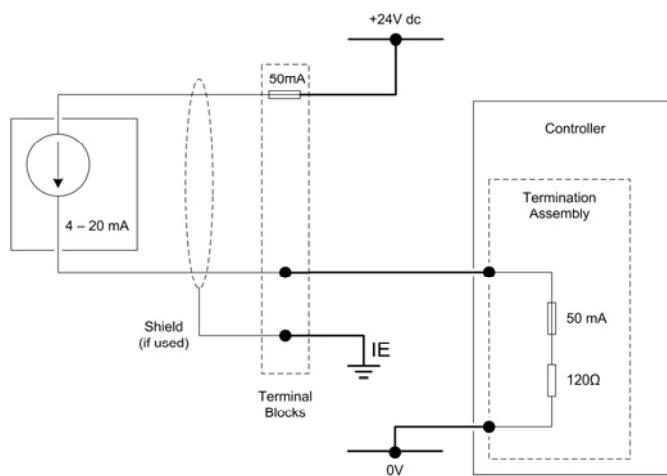
Analogue Input Field loop Circuits

These circuits can be used for simplex, dual and triple configurations of analogue input modules. Fit a fuse (as shown) in each circuit to protect the field wiring.

Recommended Field Loop Circuits

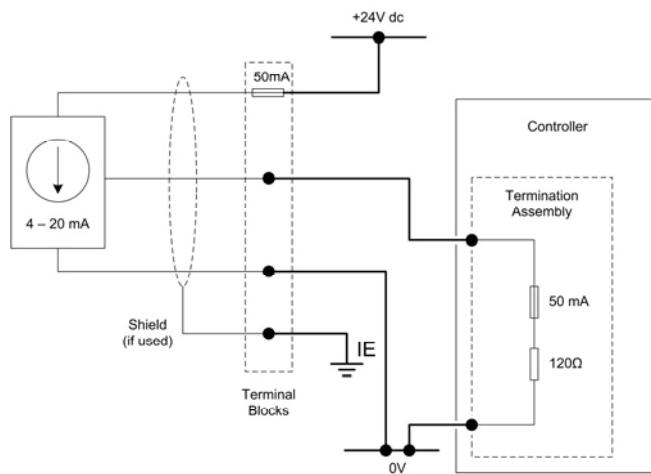
2-Wire Analogue Input

Figure 15: 2-Wire Analogue Input Field Loop



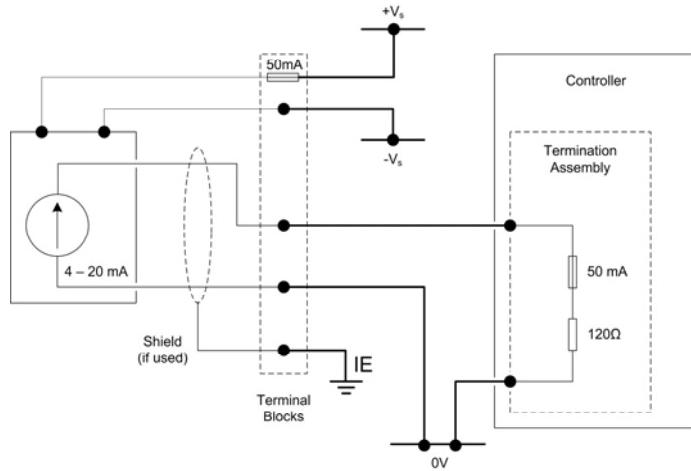
3-Wire Analogue Input

Figure 16: 3-Wire Analogue Input Field Loop



4-Wire Analogue Input

Figure 17: 4-Wire Analogue Input Field Loop

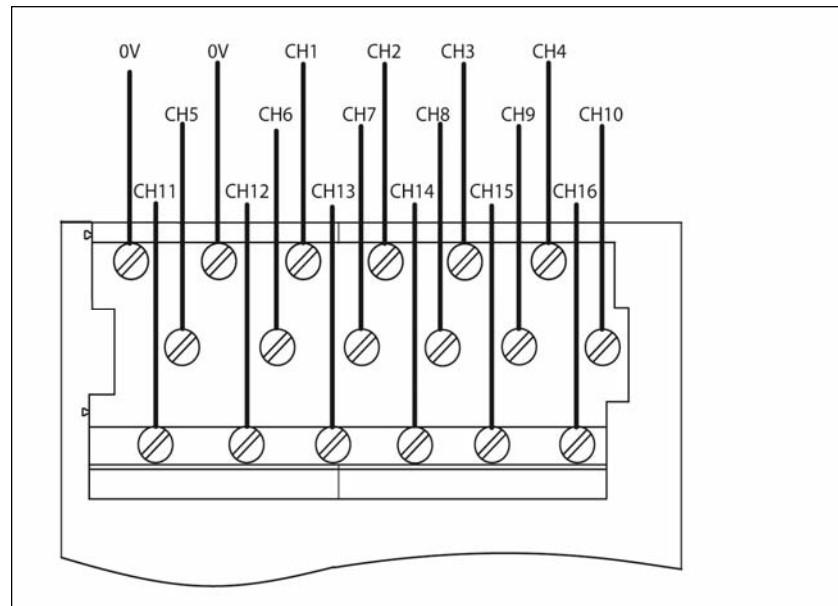


Analogue Input Slew Tolerance

It is possible during sustained periods of abnormal input current slewing that channels can be declared faulted as a consequence of diagnostics otherwise designed to ensure the channels are operating within their designed safety accuracy.

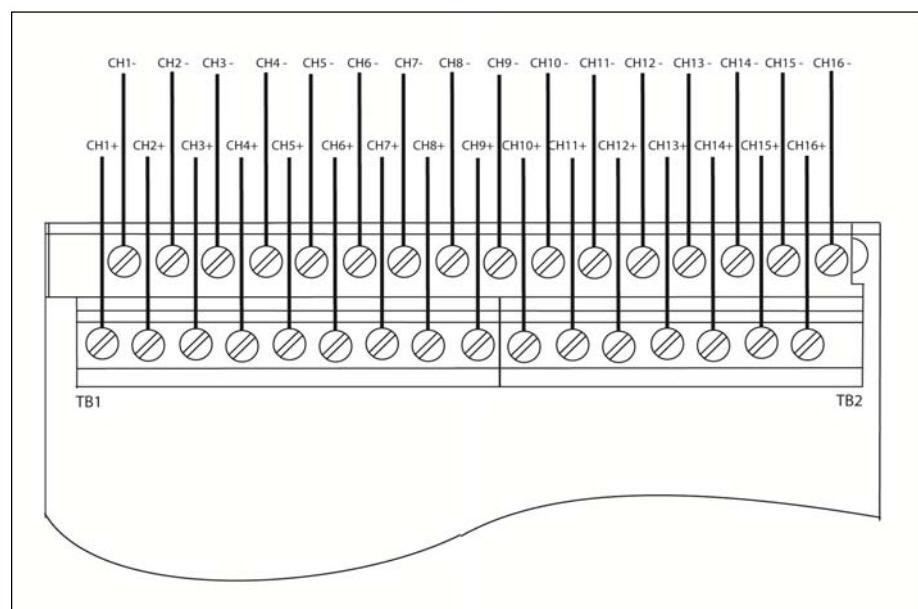
To avoid spurious declaration of channel faults it is necessary to ensure that the input signal condition satisfies the maximum slew rate criteria defined in the Solutions Handbook. Accordingly it may be necessary to condition the input signal such as by filtering, sensor slew rate configuration or by appropriate choice of process safety time.

Connections to T9831 Non-isolated Analogue Input TA — 16 Channel Simplex



- Apply a minimum tightening torque of 0.5 Nm (0.37 ft. lb.) to the terminal screws.

Connections to T9832/T9833 Isolated Analogue Input TA — 16 Channel TMR

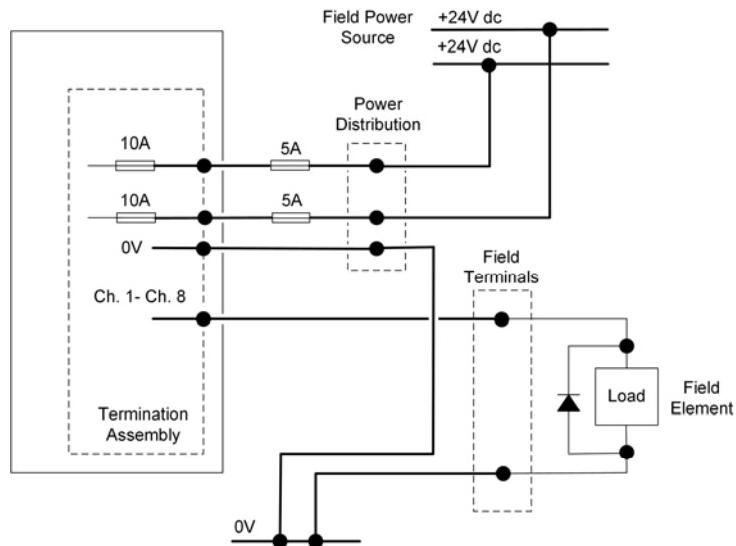


- Apply a minimum tightening torque of 0.5 Nm (0.37 ft. lb.) to the terminal screws.

Recommended Field Circuit for Digital Outputs

This circuit is applicable for simplex and dual configurations of digital output modules. The two 10 A fuses shown are included on the termination assembly within the controller. The 5 A fuses satisfy UL508 requirements for digital output field supplies, see illustration below:

Figure 18: Digital Output Field Circuit



For inductive loads, a back EMF protection diode must be fitted at the load.



A fuse rated minimum 32 Vdc, maximum 5 A for an input of 0 - 28.3 V and a maximum fuse current rating of 100 V for an input of 28.3 - 42.4 V must be installed in series with the field power terminals on modules T9451 to comply with the UL 508 certification.

Recommended Fuse Types

The 10A fuses are fitted into the termination assembly and are:

- T9902: SMF Omni-Block, Surface Mount Fuse Block 154 010, with a 10 A, 125 V Fast Acting Fuse, Littelfuse.

The field power input 5 A fuses are:

- No 396/TE5 5 A time lag fuse; UL 248-14, 125 V, T Leadfree; manufactured by Littelfuse.

NOTE	<p>1) Instead of fitting two 5 A fuses you can use Class 2 power supplies for the +24 Vdc field voltage. Class 2 is specified by the NEC as supplying less than 100 watts (at 24 V).</p> <p>2) The field power must be wired using 12 AWG wire.</p> <p>3) The field power must be supplied with an isolating source.</p> <p>4) The minimum current required for line monitoring is 20 mA for a dual pair.</p>
-------------	---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Digital Output Slew Tolerance

It is possible during sustained periods of abnormal input current slewing that channels can be declared faulted as a consequence of diagnostics otherwise designed to ensure the channels are operating within their designed safety accuracy.

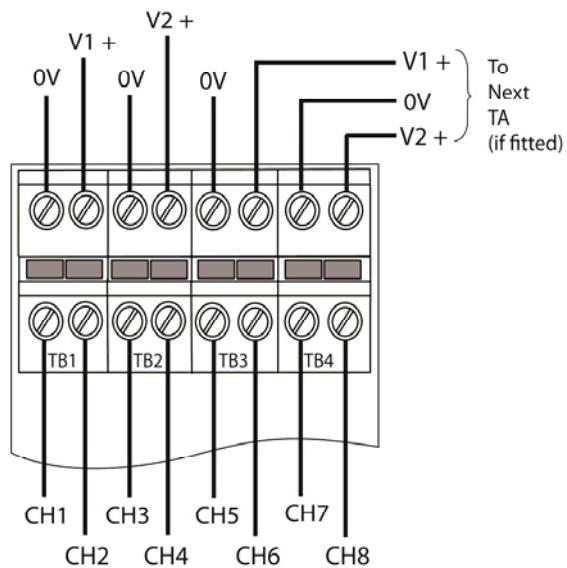
To avoid spurious declaration of channel faults it is necessary to ensure that the field supply voltage and output signal condition satisfies the maximum slew rate criteria defined in the Solutions Handbook.

Accordingly it may be necessary to condition the field supply voltage or output signal such as by filtering or by appropriate choice of process safety time.

Connections to T9851/T9852 Digital Output TA — 8 Channel Simplex/Dual

The field element wiring and field power connections are as shown:

Figure 19: Digital Output Termination Assembly Wiring



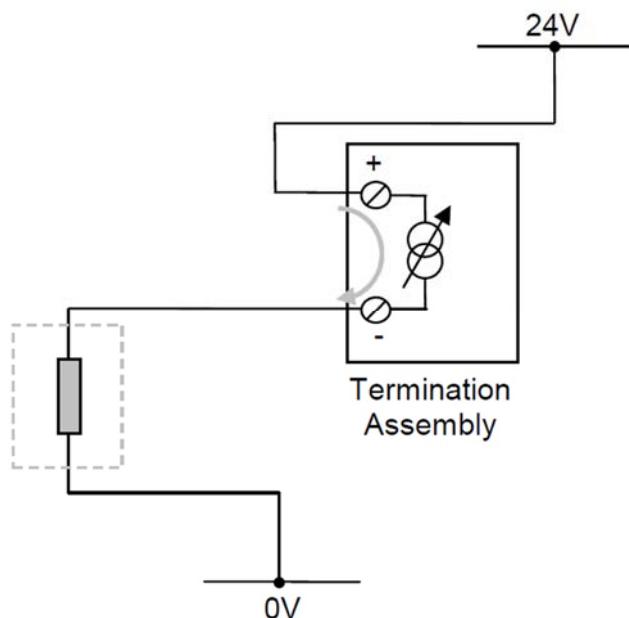
-
- Apply a minimum tightening torque of 0.5 Nm (0.37 ft. lb.) to the terminal screws.

Recommended Circuit for Analogue Outputs

These circuits are suitable for simplex and dual configurations of analogue output modules. All channels are isolated from each other but may be bridged at the '+' terminal if fed by a common system mounted supply.

System powered devices

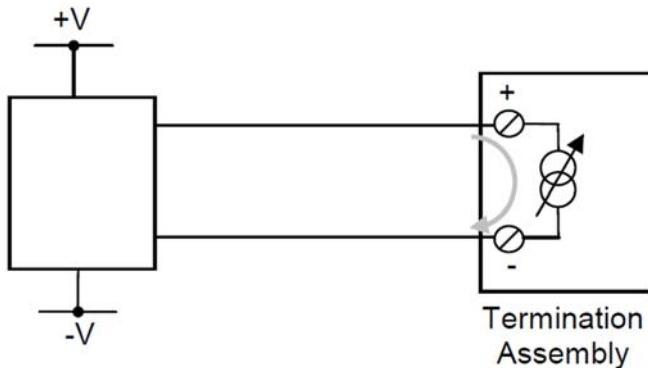
Figure 20: Analogue output Circuit



The above circuit is appropriate for devices that are powered by the system. The channel will pass a requested current between 0 mA and 24 mA. The field device could also be connected between the 24 V supply and the Loop Plus terminal.

IMPORTANT If the 24 V supply is shared between channels or between modules, the field loops will not be isolated from each other.

Field powered devices



The above circuit is appropriate for devices that are powered locally and expect a current-controlled signal loop. Ensure that the loop is wired to pass current to the Loop Plus terminal and return it on the Loop Minus terminal.

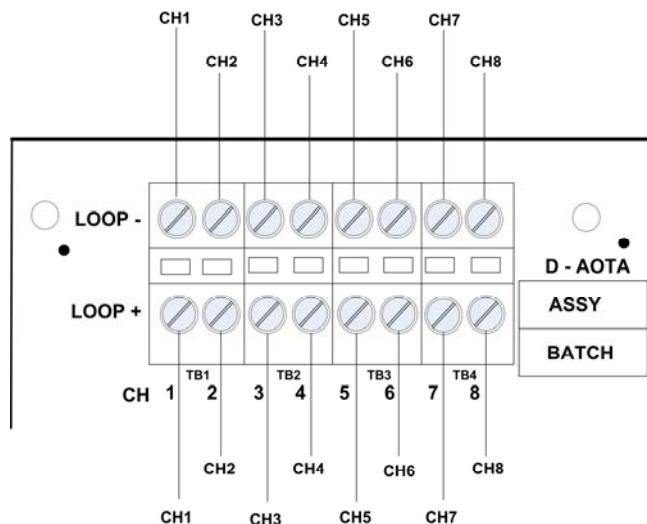
Analogue Output Slew Tolerance

Analogue output channels voltage slew is unconstrained with the limits set by the module's compliance operating voltage range.

To avoid spurious declaration of channel faults it is necessary to ensure that the field supply voltage and output signal condition satisfies the maximum slew rate criteria defined in the Solutions Handbook. Accordingly it may be necessary to condition the field supply voltage or output signal such as by filtering or by appropriate choice of process safety time.

Connections to T9881/T9882 Analogue Output TA - 8 Channel Simplex/Dual

This diagram shows the T9882. The T9881 has the same terminal arrangement.



Apply a minimum tightening torque of 0.5 Nm (0.37 ft. lb.) to the terminal screws.

Install Modules

The modules of the AADvance controller mount onto the base units. The processor module(s) mount onto the T9100 processor base unit, while the various I/O modules mount onto the T9300 I/O base unit and associated termination assemblies.

The product range includes two sizes of blanking covers to conceal unused module positions. The shorter cover is for a spare position on the processor base unit, while the taller cover is for a spare position on an I/O base unit.

Install a 9110 Processor Module

Do the following:

- Before inserting a new processor module, examine it for damage.
- The identification labels on the sides of the module will be hidden after the module is installed. Therefore before installation make a record of the location of the module and the details shown on the label.
- If you are installing more than one processor module make sure they all have the same firmware build.

Installation

1. Examine the coding pegs on the 9100 processor base unit and make sure they complement the sockets on the rear of the processor module:



2. Place the processor module on to the coding pegs. Make sure the slot on the head of the module locking screw is vertical and then push the module home until the connectors are fully mated.
3. Using a broad (9mm) flat blade screwdriver turn the module locking screw clockwise to lock.

NOTE The locking screw acts as a power interlock device and must be locked or the module will not boot up.

Replace a Faulty Processor Back-up Battery

Use the following official Rockwell Automation battery or one of an equivalent specification.

Part No and Description:

T9905: Polycarbon monofluoride Lithium Coin Battery, BR2032 (recommended type), 20 mm dia; Nominal voltage 3 V; Nominal capacity (mAh.) 190; Continuous standard load (mA.) 0.03; Operating temperature -30 °C to +80°C, supplied by Panasonic.

TIP

Battery design life is based on operating at a constant 25 °C and low humidity (high humidity, temperature and frequent power cycles are all factors that will shorten the batteries operational life).

The battery has a design life of 10 years when the processor module is continually powered; for processor modules that are un-powered, the design life is up to 6 months.

CAUTION

The battery may explode if mistreated. Do not attempt to recharge, disassemble or dispose of in a fire.

ATTENTION

La pile peut exploser si elle est maltraitée. Ne tentez pas de la recharger, désassembler ou de la brûler.

WARNING

Batteries must only be changed in an area known to be non-hazardous.

AVERTISSEMENT

Les piles ne doivent être remplacées que dans une zone réputée non dangereuse.

Procedure

To replace a faulty battery, do the following:

1. Use a small cross head screwdriver to release and remove the battery cover.



2. Remove the battery by pulling on the blue ribbon.



3. Insert a new battery, orientate it the positive (+) terminal to the right. Trap the ribbon behind the new battery so it can be removed in the future and then push the battery into the holder.
4. Put the cover back and secure it with the cross head screw.
5. Push the Fault Reset button on the processor module. The processor Healthy LED will go green (applies if the module is part of a running system).

If the battery is replaced when more than one processor module is installed then the processor clock will be updated automatically through synchronization.

If you have previously set up SNTP when you set up your processor module then the clock will be reset to the current time automatically. If you have not set up SNTP it is recommended that you do so, as this will not only reset the processor clock but will also keep the time accurately during operation. Refer to the AADvance Configuration Guide for the SNTP set up instructions. The following applies:

- If the battery is replaced when only one processor module is installed and the processor module is not powered up and SNTP has not been set up, you must set the clock to the current time as soon as practicable.
- The battery does not do any function while the processor module is powered and the application is running. The Processor's Real Time Clock provides Date and Time data for SOE functions and also for the Processor diagnostic log entries.

The specific functions that the battery maintains on complete loss of power are the following:

- Real Time Clock – The battery provides power to the RTC chip itself.
- Retained Variables – Data for retained variables is stored at the end of each application scan in a portion of RAM, backed by the battery. On restoration of power, the retained data is loaded back into the variables assigned as retained variables for use by the application scan.
- Diagnostic logs – The processors diagnostic logs are stored in the portion of RAM backed by the battery.

Set the Real Time Clock Manually

If the system has only one controller and does not have a different time server, you have to set the processor real-time clock manually using RTC variables. The following procedure assists in setting the clock:

Set up the following variables in the Dictionary

RTC Control Rack Variables (all BOOLEAN Outputs)

RTC Control: RTC_Read
RTC Control: RTC_Write
RTC Control: Year

RTC Control: Month
RTC Control: Day of Month
RTC Control: Hours
RTC Control: Minutes
RTC Control: Seconds
RTC Control: Milliseconds

RTC Status Variables (All Word Inputs)

RTC Status: Year
RTC Status: Month
RTC Status: Day of Month
RTC Status: Hours
RTC Status: Minutes
RTC Status: Seconds
RTC Status: Milliseconds

RTC Program Rack Variables

RTC Program: Year
RTC Program: Month
RTC Program: Day of Month
RTC Program: Hours
RTC Program: Minutes
RTC Program: Seconds
RTC Program: Milliseconds

Procedure to Check the Current Date and Time

1. Wire the processor variables. Refer to the topic "Wire Processor Variables".
2. Build and download the program or perform an on-line update.
3. Check the current date and time settings:
 - Enter Debug mode
 - Request IXL Restricted Access
 - Force the RTC Read Boolean and all the time fields in the RTC Control Rack Variables to TRUE

IMPORTANT

Do not force the RTC Write Boolean at this point.

- The RTC Status Variables will show the current date and time in the processor.

Procedure to Set the Date and Time

1. Unlock the RTC Read variable so it turns FALSE.
2. Select each RTC Program Rack variable and enter the date and time values.
3. Toggle the RTC Write variable TRUE then FALSE to write the new date and time setting to the processor.
4. Lock and force the RTC Read variable to TRUE.
5. The RTC Status rack now displays the new date and time of the processor.
6. Unlock all the RTC Control variables.

Install I/O Modules

Do the following:

- Before inserting a new I/O module, examine it for damage.
- The identification labels on the sides of the I/O module will be hidden when the module is installed. Therefore before installation write down the location of the module and the details shown on the label.

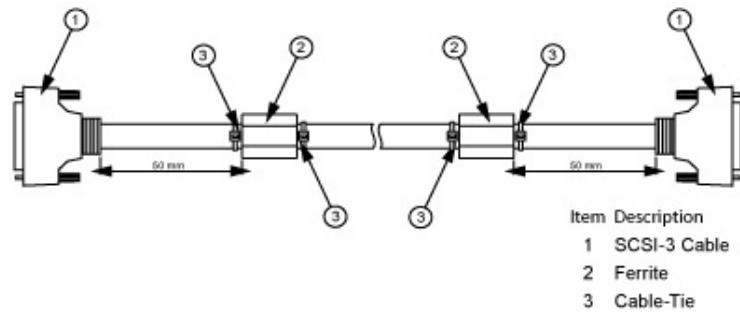
Installation

1. Examine the coding pegs on the termination assembly and make sure that they complement the sockets on the rear of the new I/O module.
2. Place the I/O module on to the dowel pins on the T9300 I/O base unit. Make sure the slot on the head of the module clamp screw is vertical and then push the module home until the module connectors are fully mated with the I/O base unit and termination assembly connectors.
3. The locking screw requires a quarter turn clockwise to lock. Use a broad (9mm) flat blade screwdriver to lock the clamp screw. The locking screw acts as a power interlock device and must be in the locked position when power is applied otherwise the module will not be configured.

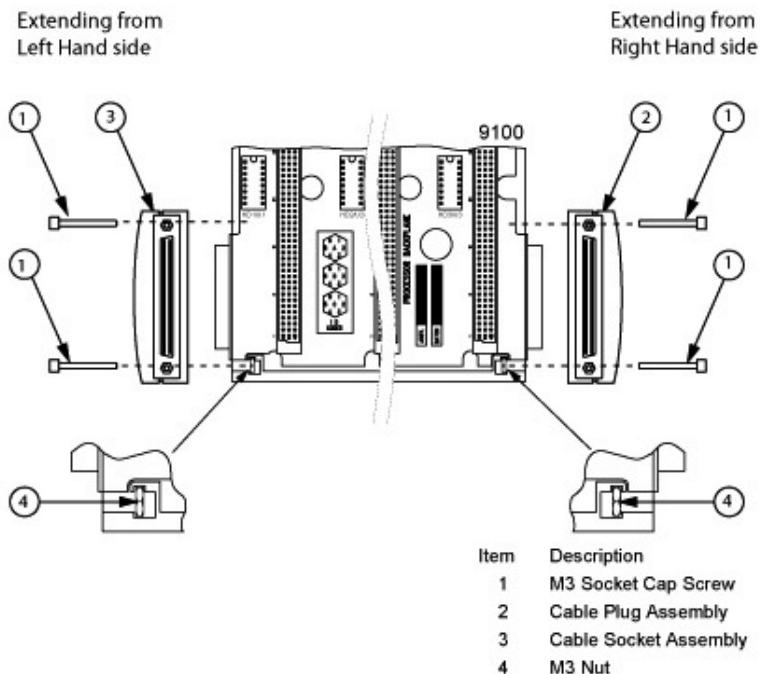
Install T9310 Expansion Cables

Use T9310 expansion cables to connect additional groups of T9300 I/O base units.

1. The ferrites supplied with the expansion cable are snap on components. Fit the ferrites 50 mm (2 in.) from each end and secure with cable ties either side of the ferrites.



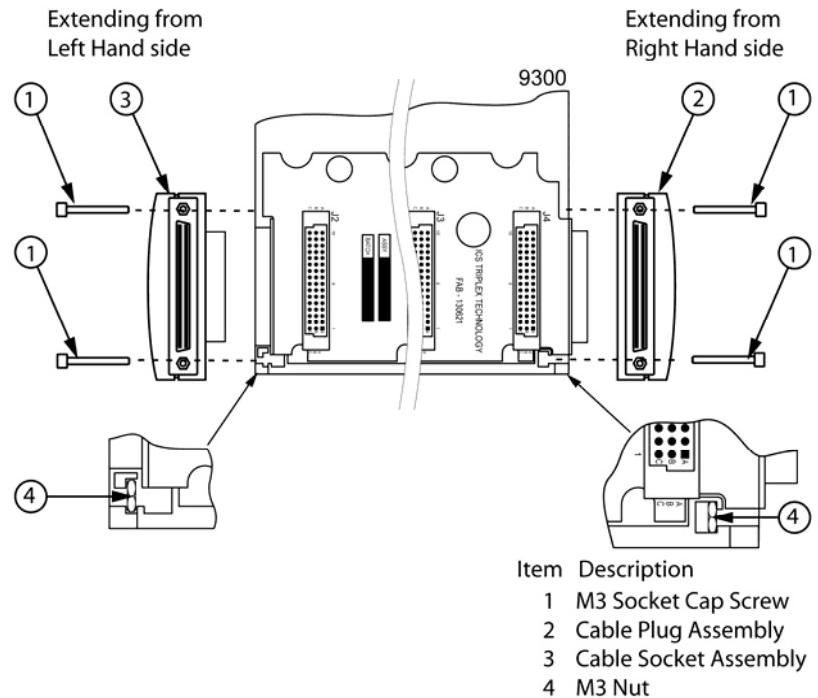
Connect Expansion Cable between T9100 Base Unit and T9300 I/O Base unit (I/O Bus2)



1. Connect the expansion cable to a T9100 processor base unit for an I/O Bus 2 connection.

- Insert a cable socket assembly into the left hand connector of the T9100 processor base unit.
 - Secure the socket assembly by inserting the two M3 socket cap screws.
 - Tighten the screws with a 2.5 mm Allen key.
 - Install the cable to the socket assembly and tighten the retaining screws by hand.
2. Insert the free end of the expansion cable into a right hand socket of a T9300 I/O base unit.
 - Insert a cable plug assembly into the right hand socket of the processor or I/O base unit.
 - Secure the plug assembly by inserting the two M3 socket cap screws.
 - Tighten the screws with a 2.5 mm Allen key.
 - Install the cable to the plug assembly and tighten the retaining screws by hand.

Connect Between a T9300 I/O Base Unit and a T9300 I/O Base Unit



1. Connect the expansion cable between a T9100 processor base unit (or a T9300 I/O Base unit) to a T9300 I/O base unit.
 - Insert a cable plug assembly into the right hand socket of the processor or I/O base unit.
 - Secure the plug assembly by inserting the two M3 socket cap screws.
 - Tighten the screws with a 2.5 mm Allen key.
 - Install the cable to the plug assembly and tighten the retaining screws by hand.
2. Connect the free end of the expansion cable to the left hand plug of an I/O base unit using a cable socket assembly.
 - Insert a cable socket assembly into the left hand connector of the T9300 processor base unit.
 - Secure the socket assembly by inserting the two M3 socket cap screws.
 - Tighten the screws with a 2.5 mm Allen key.

- Install the cable to the socket assembly and tighten the retaining screws by hand.

Fault Reporting Reference Information

Each module has a set of front panel status indicators. The function and meaning of these indicators related to each module is as follows:

Status Indicators on the 94xx Series Input and Output Module

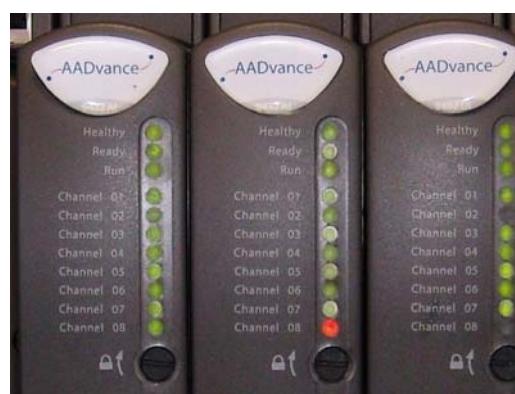


Table 10: Status Indicators on the 94xx Series Input and Output Module

Indicator	Status	Description
Healthy	OFF	No power.
	GREEN	No module faults present.
	RED	The module has one or more faults. <ul style="list-style-type: none"> • The Healthy indicator can turn RED immediately after power is applied to the module, before then turning GREEN • If Healthy is GREEN and the Ready and Run are RED then the module is said to be in its "shutdown state" refer to the Troubleshooting Manual - Chapter 3 for more information on the shutdown state.
Ready	OFF	No power or module is unlocked.
	GREEN	Locked and prepared to report channel values.
	RED	Locked but not prepared to report channel values.
Run	OFF	No power or module is unlocked.
	GREEN	Module is on-line and supplying data to/receiving data from application
	AMBER	Module is inserted into a running system but not on-line. Push the Fault Reset button on any processor module to set the module to go on-line.
	RED	Module is prepared to go on-line but no application is running.

Channel 1 - 8	OFF	Input module: field switch is open. Output module: output is in its de-energized condition. Note: If the run indicator is not green (the module is not reporting channel values), all channel indicators will be off.
	GREEN	Input module: input is on. Output module: output is in its energized condition.
	AMBER	Field fault.
	RED	Channel fault.

Status Indicators on the 9110 Processor Module



Table 11: Status Indicators on the T9110 Processor Module

Indicator	Status	Description
Healthy	OFF	No power.
	RED	<ul style="list-style-type: none"> Flashes RED briefly after being installed as the module is booting up Continuous RED means a Module has a fault.
	GREEN	<p>As the module boots up it goes GREEN, this lasts for 10 to 20 seconds.</p> <p>When the module is operational the LED stays GREEN.</p> <p>When in the recovery mode and no faults are present the LED is GREEN.</p> <p>Fault Indications:</p> <ul style="list-style-type: none"> If Healthy is GREEN and all the other indicators on the module are OFF then the module has failed to boot up. If Healthy is GREEN and Ready and Run are RED then the module is in its shutdown state.
Ready	OFF	No power.
	RED	<ul style="list-style-type: none"> Module is booting up (10 to 20 seconds) or not educated or synchronized with partners. Module is in the shutdown state.
	Flashing GREEN	The module is being educated or synchronized.
	GREEN	Module is educated and synchronized with partners.

	AMBER	Module is in Recovery Mode.
Run	OFF	No power and stays off while the module is booting up (10 to 20 seconds)
	RED	<ul style="list-style-type: none"> Module is not educated/synchronized; No application loaded; the processor module is in the Recovery Mode and the base level firmware is running. Module is in the shutdown state.
	GREEN	The module contains an application and it is running.
	AMBER	<p>Module is in Recovery Mode. or The module contains the application but the application has stopped. Press Fault Reset to start the application.</p>
System Healthy	OFF	No power and stays off while the module is booting up (10 to 20 seconds).
	RED	<p>There is a fault on one or more modules. or The application has stopped because the module has entered Recovery Mode.</p>
	GREEN	<p>No system or module faults present or The system is in Recovery Mode.</p>
Force	OFF	No power and stays off while the module is booting up (10 to 20 seconds)
	GREEN	No variables are being locked/forced
	AMBER	<p>Module is in the Recovery Mode. or An operating controller has at least one variable being locked/forced.</p>
Aux	OFF	No power and stays off while the module is booting up (10 to 20 seconds), or under application control.
	GREEN	The module is under application control.
	AMBER	<p>Module is under application control. or The module is in the Recovery Mode.</p>
Serial 1 and 2	OFF	No power and stays off while the module is booting up (10 to 20 seconds).
	RED	Serial port pulse stretched Tx.
	GREEN	Serial port pulse stretched Rx.
	AMBER	Quickly alternating Tx and Rx activity.
Ethernet 1 and 2	OFF	No power and stays off while the module is booting up (10 to 20 seconds)
	GREEN	Ethernet link present
	AMBER	Tx or Rx activity on Ethernet Port

Page intentionally left blank.

System Start-Up

This chapter describes a structured approach to the start up of a controller system.

When the checks and module installation and start up is completed successfully the system is ready for you to configure your system using the AADvance Workbench (see AADvance Configuration Guide for set up and configuration procedures) and then carry out Functional Acceptance Testing.

Recommendations to Manage Test Documentation

It is important that the system is documented when it is installed and this documentation is maintained throughout the testing process system.

1. Obtain these items of documentation:
 - I/O wiring database with checklist
 - Complete set of drawings
 - Bill of materials
2. Ensure that each item of documentation is the latest issue.
 - Mark each item as 'Test Copy'.
3. Create a system activity log book and ensure the log book accompanies the system into test.
 - Allocate an entry number for each test and record each test against its number in the log book.
 - If, during functional tests, the system does not behave as expected, record the problem in the log book. Allocate a new entry and fault number for each problem.

System Physical Design Check

Assess the physical design of the system to determine whether it is ready to be tested. Do the following:

- Verify there is physical segregation of any mains supply circuits from the 24 Vdc controller circuits.

- Review the arrangements of terminals and the provision of cable entries for field wiring.
- Evaluate the ease of access for maintenance activities.

Procedure to Verify Build State

Assess the build state of the system against the test documentation. Do the following:

- Compare the arrangement of the system with the General Arrangement drawings to make sure the system has been manufactured and assembled correctly.
- Verify that every item shown in the bill of materials on the General Arrangement drawings is either in place or is available to be installed.
- Check that any special features, configurations or options called for on the drawings are present and correct.
- Check nameplates and identification labels against the drawings.

Identify any non-conformance found between the system and the drawings. If appropriate, correct the drawing. Record each non-conformance in the log book.

Procedure to Conduct the Mechanical Inspection

Carry out a mechanical inspection to verify that an acceptable standard of workmanship has been achieved in the assembly and wiring and that the test arrangements are correct. Do the following:

- Visually inspect the controller and verify that base units, modules and terminals are free of damage.
- Review the termination of system cabling against the drawings.

Procedure to Check Ground Bonding



SHOCK HAZARD:

Connect the AC safety busbar to the building earth (ground) before doing electrical testing or applying power to the system. Failure to follow these instructions can cause injury to persons.

Check that the ground continuity does not exceed $0.2\ \Omega$.

- Check that the isolation between grounds is $10M\ \Omega$.

Procedure to Check Power Distribution Integrity

IMPORTANT Before you begin this task, you must have checked the ground bonding.

Check the integrity of the power distribution system to verify that each power distribution sub-section is wired in accordance with the drawings and that the subsections are isolated from each other. Do the following:

1. Make sure all power sources are isolated.
2. Switch off all circuit breakers and open distribution fuses.
3. Remove all modules from the controller.
4. Check that the circuit breakers and fuses of the correct capacity and rating are installed in the correct locations.
5. Check that all subsections are isolated from each other.

Power Distribution and First Power Up

NOTE Before you begin this task, you must have checked the power distribution integrity.

The power distribution and first power up verifies that the power distribution circuits function as designed and as detailed in the drawings. It shows the correct voltages are appearing, and only in the correct places. It also provides an opportunity to verify correct operation of any power indicators outside the controller itself.

Do the following:

1. Make sure all modules are removed.
2. Trip all circuit breakers and disengage all power distribution fuses and field fuses.
3. Apply power to the incoming power terminals.
4. It is good practice to switch on power supplies to field devices before supplies to the controller. Devise a formal sequence in which to switch on individual circuits.
 - In sequence, check each circuit breaker or fuse for zero volts on the destination side, and then close the circuit breaker or fuse and verify that the appropriate voltage appears.
 - Check that any associated power indicator is lit.

- As each circuit breaker is tested, leave the breaker in the ‘on’ position so that any unwanted connection between different power circuits can be detected.
5. Trip and re-instate each circuit breaker in turn and verify the correct circuits are isolated and restored. Similarly disengage and replace each fuse and verify the associated circuits.
 6. At the same time verify correct operation of any power indicators supplied with the system.

Start Up Process

Once the procedures for power distribution tests have been successfully completed, the controller is ready for installation of its modules and its second power up. The installation process should be completed in the following order:

1. Switch off power to the controller — both field power and controller power sources.
2. Make a record of the module and base unit serial numbers for future reference.
3. Reinstate the power.
4. Install the modules in the following sequence.
5. Install the **program enable key** to the connector labeled **KEY** on the processor base unit.
6. Install the first Processor module.
 - Refer to the Processor Module start-up process.
7. Install the second or the third processor module (if required).
 - Refer to the Processor Module start-up process.
8. Install the I/O modules.
 - Refer to the I/O Module start up process.
9. Check system status indications show the system is on-line and operating as expected.

System Configuration and application programming

When the hardware is installed and running you need to set up the system configuration using the AADvance Workbench:

- For Workbench 2.0 refer to the AAdvance Configuration Guide Doc No 553633 for the detailed instructions on configuring a system.
- For Workbench 1.3 refer to the AAdvance Configuration Guide Doc No 555063 for the detailed instructions on configuring a system.

Processor Module Start Up Process

NOTE	When inserting more than one processor module they MUST be inserted one at a time and the module be allowed to educate (in the case of a 2 nd and 3 rd processor).
-------------	------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Table 12:
Single Processor Module Installation Procedure (New Processor Module)

Step	Task																				
1.	With the power switched on place the processor module into slot A on the Base Unit connectors and push the module home until the connectors are fully mated. Turn the locking screw and lock the module in position.																				
2.	All LEDs are off and after applying power the processor will show the following status indications: <table> <tr> <td>Healthy</td> <td>Flashes RED for a second then goes GREEN as the module boots up (10-20 seconds)</td> </tr> <tr> <td>Ready</td> <td>Will stay OFF as the module boots up (10 to 20 seconds) then goes RED</td> </tr> <tr> <td>Run</td> <td>Will stay OFF as the Module boots up (10 to 20 seconds) then goes RED</td> </tr> <tr> <td>System Healthy</td> <td>Will stay OFF as the Module boots up (10 to 20 seconds) then goes GREEN</td> </tr> <tr> <td>Force</td> <td>Will stay OFF as the Module boots up (10 to 20 seconds) then stays OFF until the module has educated.</td> </tr> <tr> <td>Aux</td> <td>Will stay OFF as the Module boots up (10 to 20 seconds) then depends on data connection.</td> </tr> <tr> <td>Serial 1</td> <td>Will stay OFF as the Module boots up (10 to 20 seconds) then depends on data connection</td> </tr> <tr> <td>Serial 2</td> <td>Will stay OFF as the Module boots up (10 to 20 seconds) then depends on data connection</td> </tr> <tr> <td>Ethernet 1</td> <td>Will stay OFF as the Module boots up (10 to 20 seconds) then depends on data connection</td> </tr> <tr> <td>Ethernet 2</td> <td>Will stay OFF as the Module boots up (10 to 20 seconds) then depends on data connection</td> </tr> </table>	Healthy	Flashes RED for a second then goes GREEN as the module boots up (10-20 seconds)	Ready	Will stay OFF as the module boots up (10 to 20 seconds) then goes RED	Run	Will stay OFF as the Module boots up (10 to 20 seconds) then goes RED	System Healthy	Will stay OFF as the Module boots up (10 to 20 seconds) then goes GREEN	Force	Will stay OFF as the Module boots up (10 to 20 seconds) then stays OFF until the module has educated.	Aux	Will stay OFF as the Module boots up (10 to 20 seconds) then depends on data connection.	Serial 1	Will stay OFF as the Module boots up (10 to 20 seconds) then depends on data connection	Serial 2	Will stay OFF as the Module boots up (10 to 20 seconds) then depends on data connection	Ethernet 1	Will stay OFF as the Module boots up (10 to 20 seconds) then depends on data connection	Ethernet 2	Will stay OFF as the Module boots up (10 to 20 seconds) then depends on data connection
Healthy	Flashes RED for a second then goes GREEN as the module boots up (10-20 seconds)																				
Ready	Will stay OFF as the module boots up (10 to 20 seconds) then goes RED																				
Run	Will stay OFF as the Module boots up (10 to 20 seconds) then goes RED																				
System Healthy	Will stay OFF as the Module boots up (10 to 20 seconds) then goes GREEN																				
Force	Will stay OFF as the Module boots up (10 to 20 seconds) then stays OFF until the module has educated.																				
Aux	Will stay OFF as the Module boots up (10 to 20 seconds) then depends on data connection.																				
Serial 1	Will stay OFF as the Module boots up (10 to 20 seconds) then depends on data connection																				
Serial 2	Will stay OFF as the Module boots up (10 to 20 seconds) then depends on data connection																				
Ethernet 1	Will stay OFF as the Module boots up (10 to 20 seconds) then depends on data connection																				
Ethernet 2	Will stay OFF as the Module boots up (10 to 20 seconds) then depends on data connection																				
4.	Install a Program Enable Key. Download a correct application and push the FAULT RESET button. When a valid application is downloaded the module shows the following indications: <table> <tr> <td>Valid application downloaded</td> <td></td> </tr> <tr> <td>Healthy</td> <td>GREEN</td> </tr> <tr> <td>Ready</td> <td>GREEN</td> </tr> </table>	Valid application downloaded		Healthy	GREEN	Ready	GREEN														
Valid application downloaded																					
Healthy	GREEN																				
Ready	GREEN																				

Step	Task
Run	RED to GREEN (Flashes GREEN as the module educates)
System Healthy	GREEN
Force	GREEN
Aux	Off (Depends on application)
Serial 1	Depends on data connection
Serial 2	Depends on data connection
Ethernet 1	Depends on data connection
Ethernet 2	Depends on data connection

Procedure for Installation of a Second and Third Processor

The second and third processor modules must have the same firmware version as the first processor. If the firmware revision is different upgrade the firmware using the ControlFLASH utility.

IMPORTANT When inserting a second and third processor module they MUST be inserted one at a time and allowed to educate before inserting the next one.

Step	Task
1.	<p>Place the processor module on slot B on the Processor Base Unit connectors and push the module home until the connectors are fully mated. Turn the locking screw with a flat bladed screwdriver and lock the module in position.</p> <p>All the Module LEDs are OFF until the module is installed. As soon as the module receives power it will boot up then educate and show the following indications:</p>
	<p>Healthy Flashes RED for a second then goes GREEN as the module boots up (10 to 20 seconds)</p> <p>Ready Will stay OFF as the module boots up (10 to -20 seconds) then goes RED for 10 seconds then flashes GREEN as it educates and lastly it goes to steady GREEN</p> <p>Run Will stay OFF as the module boots up (10 to 20 seconds) then goes RED until educated and then it goes AMBER</p> <p>System Healthy Will stay OFF as the Module boots up (10 to 20 seconds) then goes GREEN</p> <p>Force Will stay OFF as the Module boots up (10 to 20 seconds) then stays OFF until the module has educated and the application is running</p> <p>Aux Will stay OFF as the Module boots up (10 to 20 seconds) then is depends on data connection</p> <p>Serial 1 Will stay OFF as the Module boots up (10 to 20 seconds) then is depends on data connection</p>

Step	Task
	Serial 2 Will stay OFF as the Module boots up (10 to 20 seconds) then is depends on data connection
	Ethernet 1 Will stay OFF as the Module boots up (10 to 20 seconds) then is depends on data connection
	Ethernet 2 Will stay OFF as the Module boots up (10 to 20 seconds) then is depends on data connection

When the Run indicator goes AMBER push the Fault Reset button and the processor will show the following indications:

2.	Healthy	GREEN
	Ready	GREEN (will flash for a short time as the module educates)
	Run	AMBER to GREEN (AMBER as the module educates)
	System Healthy	GREEN
	Force	Off to GREEN
	Aux	Depends on application
	Serial 1	Depends on data Connection
	Serial 2	Depends on data Connection
	Ethernet 1	Depends on data Connection
	Ethernet 2	Depends on data Connection
3.	To insert a 3rd processor module repeat step 1 and insert in slot C.	

I/O Module Start-up Process

The start-up sequence is different when a module is installed into an on-line system that is running compared to installing the module into a system that is off-line and has processor modules but no I/O modules installed.

Table 13: Single Module or First Module of a group Installation Procedure

Step	Task	
1.	This procedure applies to a single module installation or the first module of a redundant group installation.	
2	Install the I/O module and turn the locking screw to the lock position.	
3.	The input module will show the following status indications:	
	Healthy	GREEN
	Ready	RED
	Run	RED
	Channel 1 – 8	Off
4.	The input module will follow its start-up sequence and the module will educate.	
5.	After approximately 3 seconds the module will now show the following status indications:	
	Healthy	GREEN
	Ready	GREEN
	Run	AMBER
	Channel 1 – 8	Off
6.	Push the Fault Reset button on the processor module and the Run indication goes GREEN.	
7.	The module will now be on-line with the following status indications:	
	Healthy	GREEN
	Ready	GREEN
	Run	GREEN
	Channel 1 – 8	Dependent on channel status
8.	If the module fails to educate (and go on-line) replace the module.	

Table 14: Second or third Module of a Group Installation Procedure

Step	Task	
1.	This procedure applies to a second or third module of a redundant group installation.	
2	Install the Input/Output Module and turn the locking screw to the lock position.	
3.	The module will provide the following status indications:	
	Healthy	GREEN
	Ready	RED

	Run	RED
	Channel 1 – 8	Off
4.	The input module will follow its start-up sequence and the module will educate.	
5.	After approximately 3 seconds the module will now make the following status indications:	
	Healthy	GREEN
	Ready	GREEN
	Run	AMBER
	Channel 1 – 8	Off
6.	Push the Fault Reset button on the processor module and the Run indication goes GREEN.	
7.	The module will now be on-line with the following status indications:	
	Healthy	GREEN
	Ready	GREEN
	Run	GREEN
	Channel 1 – 8	Dependent on channel status
8.	If the module fails to educate and go on-line replace the module.	

Processor Firmware Upgrades

You can check the firmware revision of your processor modules without removing them to read the label and you can upgrade the firmware revision of the processor modules. Upgrading the firmware in the 9110 processor module is done in the Recovery Mode and is a two-stage process:

- **Stage 1:** Run the latest version of 350720_xxx_ControlFLASH.msi program to install the ControlFLASH firmware upgrade kit for the Recovery Mode on your PC. Then run the ControlFLASH utility to upgrade your processor module and install the Recovery Mode. If your module is delivered with the Recovery Mode installed then this stage is not necessary.

Stage 1 must be performed individually on each processor; it does not matter if you download the Recovery Mode one at a time in a specific slot or in their own slots.

- **Stage 2:** Reboot the processor and press and hold the Fault Reset button to enter the Recovery Mode. Then run the latest version of 354400_xxxx_ControlFLASH.msi program to install the ControlFLASH to upgrade your processor's OS, FPGA, LSP and BUSP.

When stage 1 is completed ControlFLASH can be used to upgrade three processor modules in the same processor base unit all at the same time.

NOTE	Detailed information and procedures on firmware revision are given in the AADvance Configuration Guide Doc No: 553633 and AADvance Configuration Guide Doc No: 555063 for Workbench 2.0.
-------------	------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Tools and Resources

You will need the ControlFLASH firmware upgrade kit.

- Quick Start and RSLinx Classic Lite software or better.
- ControlFLASH programming tool, along with its required support drivers and on line HELP.
- Firmware for the processor modules being upgraded.

Stage 1: Install ControlFLASH for Recovery Mode and Secondary Boot Firmware

This procedure will install Recovery Mode and Secondary Boot Firmware.

1. Run the '350720_102_ControlFLASH.msi' file.

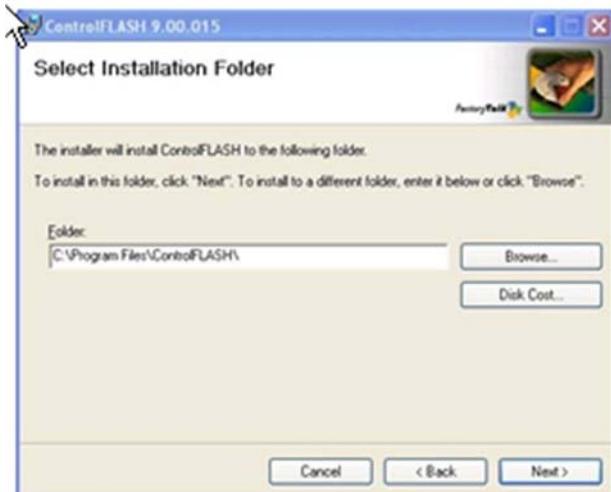


2. Click Next

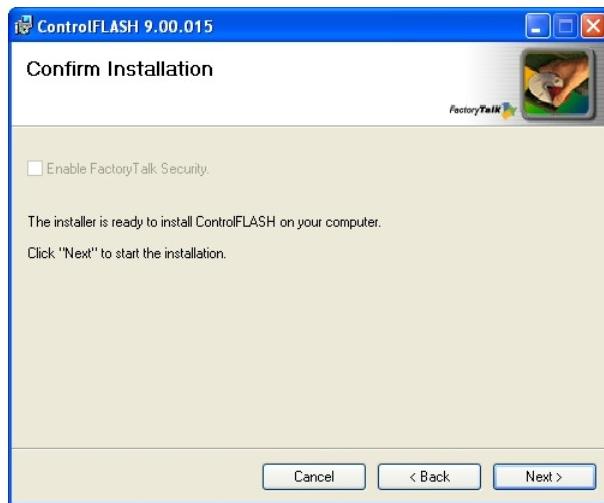
3. Read and agree to the license and click Next



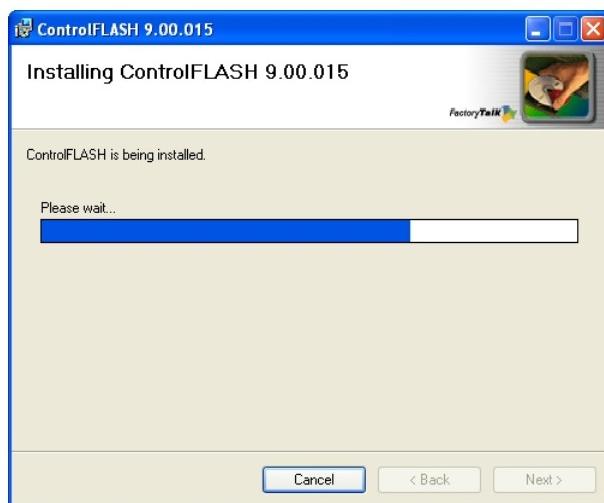
4. Click Browse to select the location of the installation or Next to select the default location.



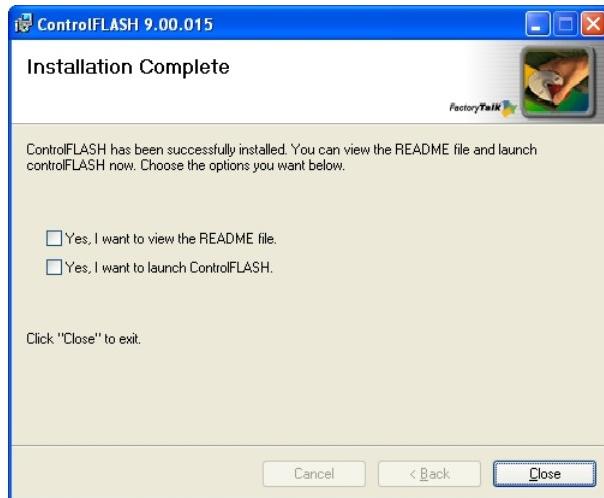
5. Click Next to start the installation.



- ControlFLASH installs.



- To launch ControlFLASH select the Yes I want to launch ControlFLASH option, then click Close.



- ControlFLASH will launch and you can now upgrade the Processor Module firmware.

Upgrade the Processor Module Recovery Mode Firmware

This is the recommended procedure to upgrade the processor module firmware using the ControlFLASH Utility.

NOTE	ControlFLASH can upgrade three processor modules at once when installed into a 9100 base unit and they are in the Recovery Mode. To do this press and hold the Fault Reset button on all three processors when they are being powered up during a power on /off cycle until the AUX LED goes Amber.
-------------	-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

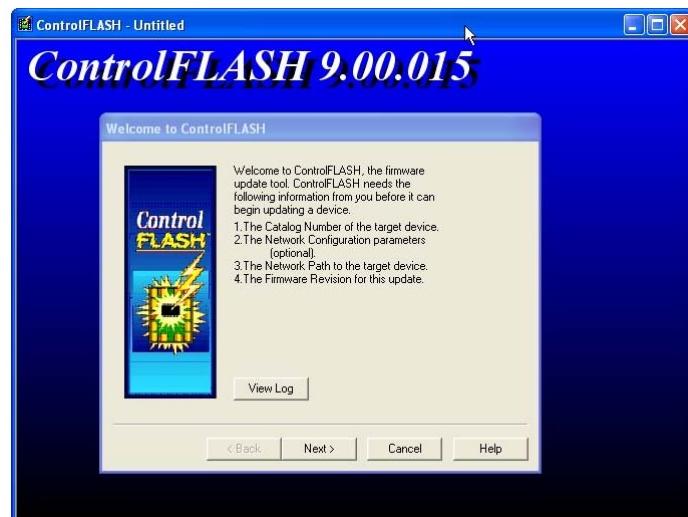


WARNING: FIRMWARE UPGRADE DANGER TO A RUNNING SYSTEM

Do not attempt to upgrade firmware on a running system. ControlFLASH will not warn you that a system is running and you will lose control of the application when the system reboots.

- Run the ControlFLASH software by either:
 - Launching from the installation

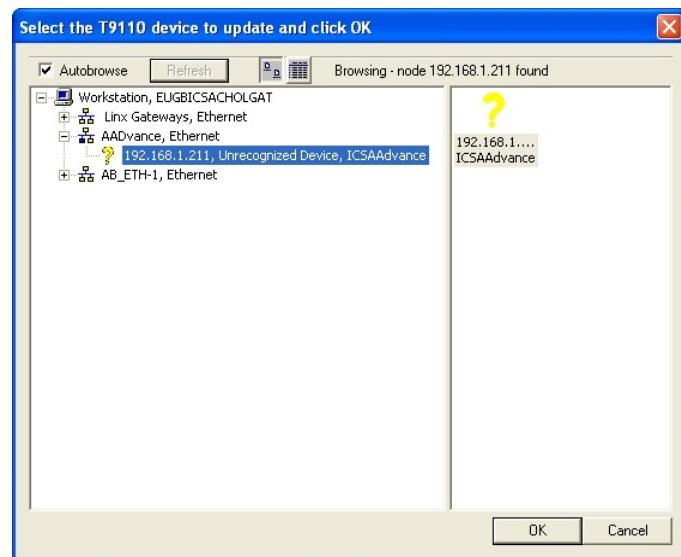
- Double clicking the desktop icon
- Launching from the Start button



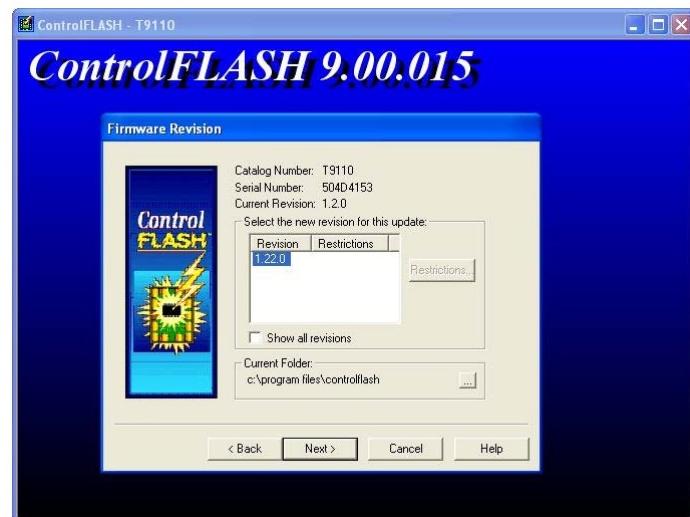
2. Click Next.
3. Select T9110 from the list.



4. Browse to the device in the RSLinx window



5. Select the firmware revision for the latest Release.



6. Check the summary details, click Finish



The continue message is displayed:



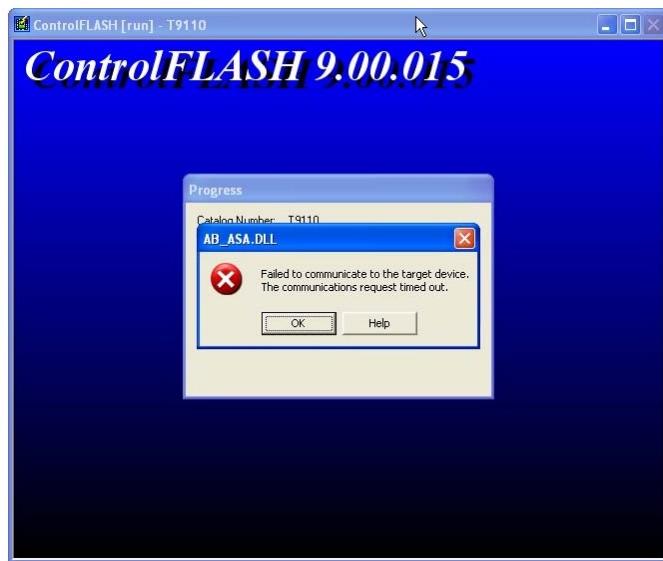
7. Click Yes to continue with the update

- A progress bar is displayed

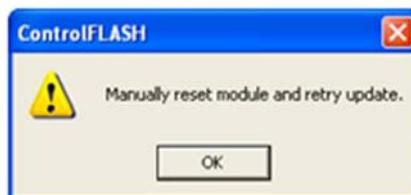


- When the progress bar reaches the end, it may take several minutes for the next screen to appear.

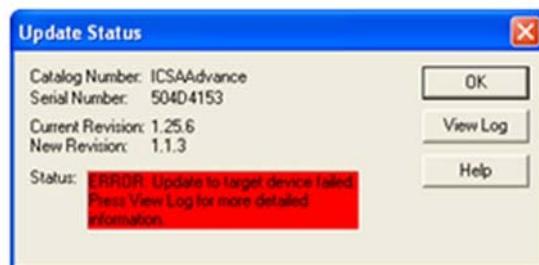
NOTE It has not locked up! Wait until the next message box appears!
You may get a "Comms error message" as AADvance
processors do not automatically reboot as ControlFLASH
expects them to but the firmware download should have
completed correctly.



1. Click OK.
 - Wait another couple of minutes and the same message will appear again.
2. Click OK.
 - The following message now appears.



3. Click OK and another error message is displayed.



4. Click OK then Cancel to Exit ControlFLASH.

5. Reboot the processor module by switching the power OFF then ON and hold in the Fault Reset button as the module reboots until the Aux LED goes amber.

The processor module(s) will reboot into the Recovery Mode indicated by the following LED states on the processor module.

Healthy	Green (dependent on Module health)
Ready	Amber
Run	Amber
System Health	Green (dependent on system health)
Force	Amber
Aux	Amber

Stage 2: Install ControlFLASH for System Firmware

This procedure describes how to upgrade the system firmware for the 9110 processor module.

The procedure that follows is basically the same as for stage 1.

1. Run the 354400_102_ControlFLASH.msi file.
2. Click NEXT.
3. Read and agree the License.
4. Click Browse to select the location of the installation or Next to choose the default location.
5. Click Next to confirm the installation.
 - ControlFLASH installs and shows the progress bar.
6. Click Yes I want to launch ControlFLASH, then click Close.

Upgrade Processor OS, FPGA, LSP and BUSP Firmware



ATTENTION: Do not attempt to upgrade firmware on a running system. ControlFLASH will not warn you that a system is running and you will lose control of the application when the system reboots.

This procedure describes how to upgrade the processor module firmware using ControlFLASH.

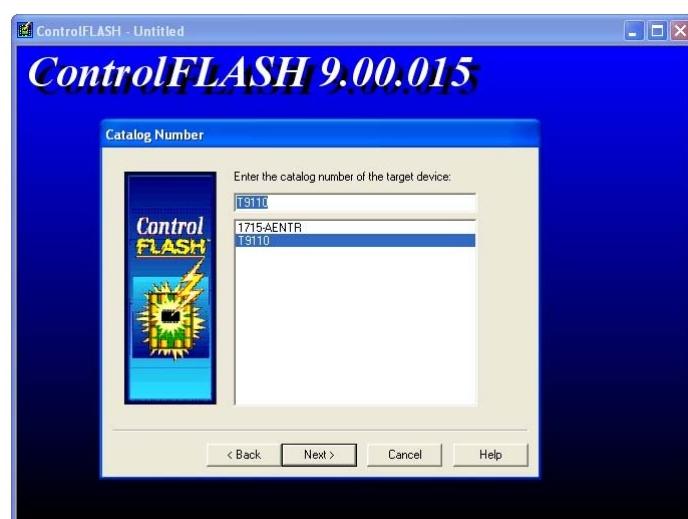
TIP ControlFLASH can upgrade three processor modules at the same time when installed into a 9100 base unit.

1. Run the ControlFLASH software by either:

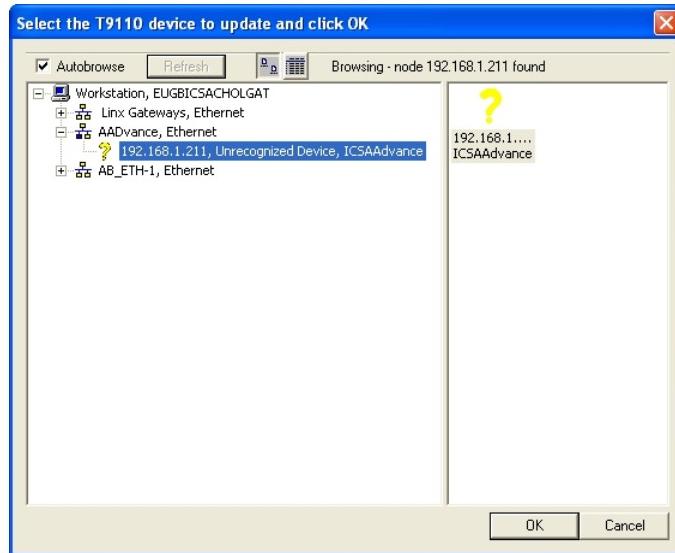
- Launching from the installation
- Double clicking the desktop icon
- Launching from the Start button



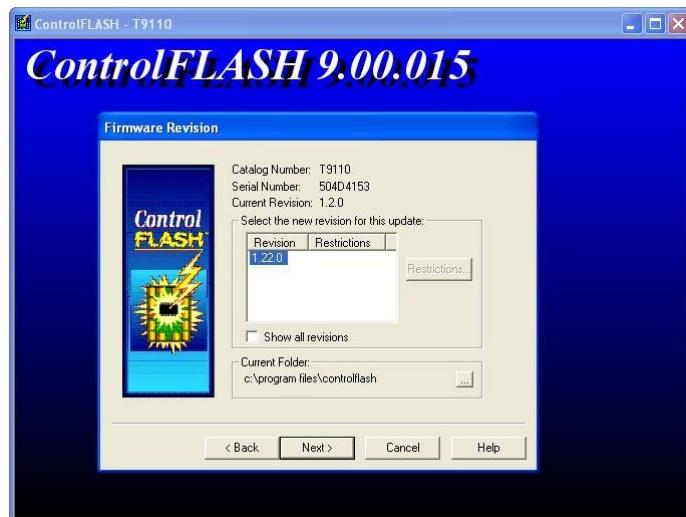
2. Click Next.
3. Select T9110 from the list.



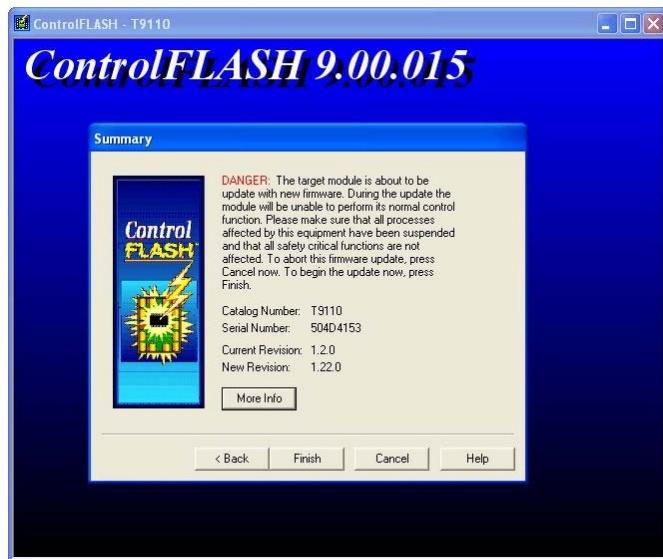
4. Browse to the device in the RSLinx window



5. Select the firmware revision for the latest Release.



6. Check the summary details, click Finish



The continue message is displayed:

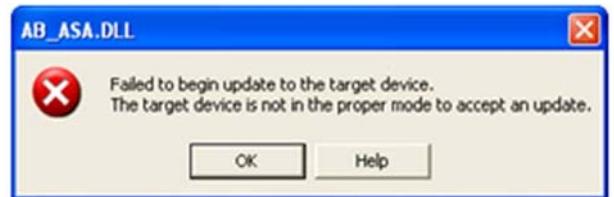


7. Click Yes to continue with the update

- A progress bar is displayed



If the processor is not in the Recovery Mode the following error is displayed.



Follow the procedure in Stage 1 to download the recovery Mode.

- After the progress bar reaches the end, it may take several minutes for the next screen to appear.



- Use the View Module Firmware Versions procedure to verify that the upgrade has worked.

Setting the Controller IP Address for AAdvance Workbench Communications

The AAdvance system uses Internet Protocol (IP) to carry communications between the controller and the AAdvance Workbench. This chapter shows you how to set up the IP address in the controller. It is convenient to set up the controller resource number at the same time.

Controller IP Address

The AAdvance controller stores its IP address data in non-volatile memory in the 9100 processor base unit. The data is independent of the 9110 processor modules in the controller, and so the controller keeps the address information when you remove a processor module.

You must set up the IP address data when you create a new system, or if you fit a new processor base unit.

After having set up the IP address data in the controller, you can configure the AAdvance Workbench to find the controller on the network.

Troubleshooting AADvanceDiscover Communications

This procedure describes how to activate communications using the Discover tool. After completing the steps, refresh the Discover tool's list of modules to test for communications.

1. Ensure that the Ethernet cable is plugged into a socket above a fitted AADvance controller – communications will not ‘pass through’ unused slots.
2. Ensure that the controller is activated by turning the locking bar. Wait for the Ready LED to go green before refreshing the Discover tool. (The communications tasks are not active until it is 'Ready').
3. Do not use an office network. Use an isolated hub or switch between the computer and AADvance controller. Check that the hub/switch has LEDs lit for the ports to both computer and controller, showing that the ports are working.
4. Open the Network Connections window. Open the Properties of the computer’s network adapter (as used for configuring AADvance). Un-tick all protocol "items" which are not immediately necessary, especially "Check Point SecuRemote" and "iPass Protocol" (if present). You will need to leave "Internet Protocol" (or) "IPv4" and "IPv6", "Client for Microsoft Networks", "File and Printer Sharing" and "Network Monitor Driver" (if present) for normal Windows operation.
5. Disable the Windows Firewall, or any third-party firewalls and shields.
6. If you are using a laptop, disable Wireless. If you have more than one network connection, disable the one you are not using. The Discover tool installed with AADvance Workbench release 1.2 (1.20.109) will not discover with more than one network connection available.

Configure the Controller Resource Number in the Controller

When assembling a new AADvance controller (or install a new 9100 processor base unit) you have to configure the resource number stored in the controller. The resource number is a type of device address, and it must also be configured in the application.

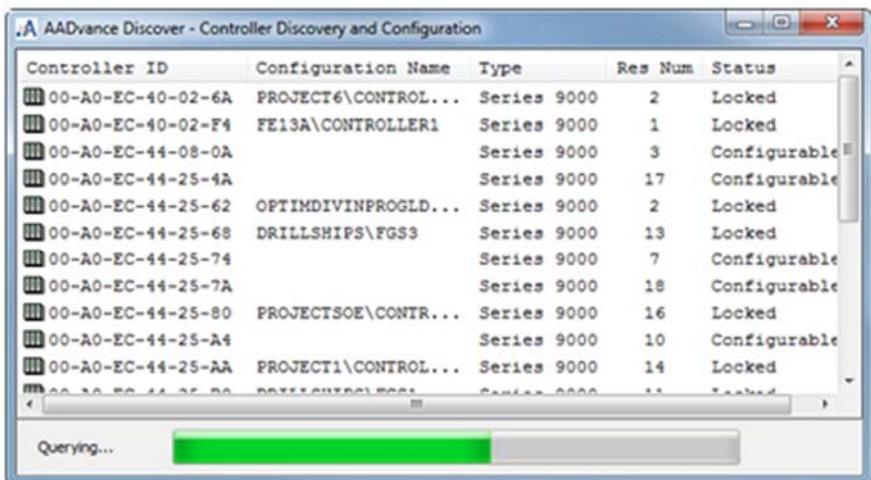
The procedure to configure the resource number uses the AADvance Discover utility. To set the resource number do the following:

1. Write down the controller's MAC address (Controller ID) displayed on a label on the processor base unit. Install at least one 9110 processor module into the processor base unit.
2. Make sure the program enable key is inserted in the KEY connector on the processor base unit.

3. Start the AADvance Discover tool from the Start menu:

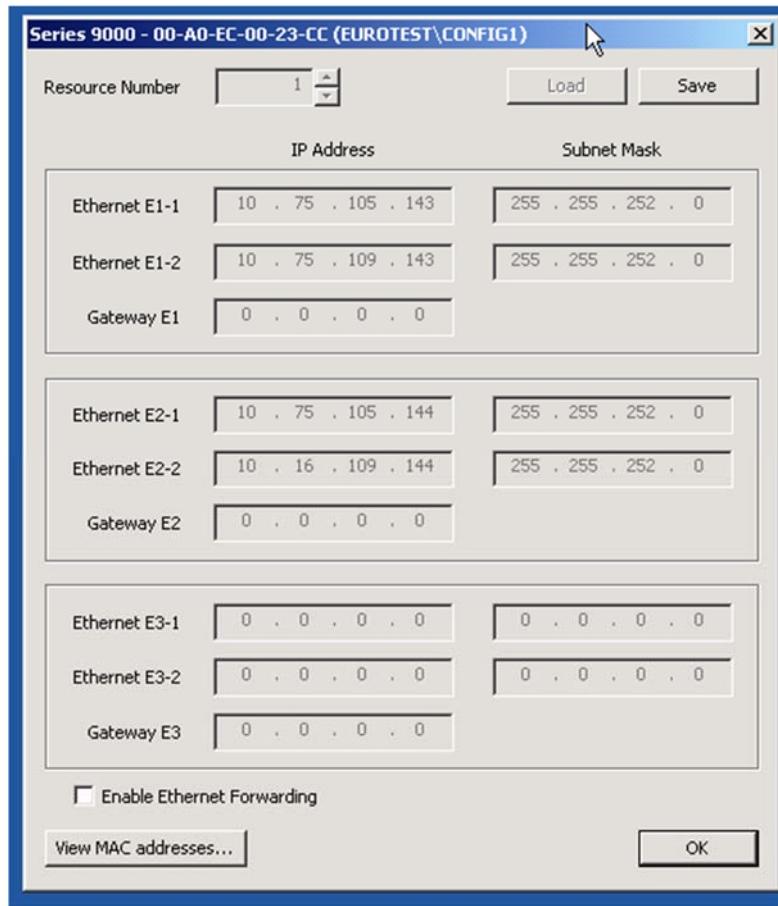
- Start → All Programs → AADvance → AADvance Discover.

The AADvance Discover utility scans the network for controllers and creates a list.



4. Locate the controller in the list and make sure that the status of the controller is **Configurable**.
5. Double-click the MAC address in the Controller ID field.

- The resource and IP Address dialog box is displayed.



- Enter the resource value into the Resource Number field, then click Apply.
 - Returning to the main window of the utility, the controller status will show Pending Restart.
- To finish the update, turn off the power to the controller.
- Start the controller. Refresh the screen to make sure that the new resource number is shown in the resource field and that the controller status is configurable.

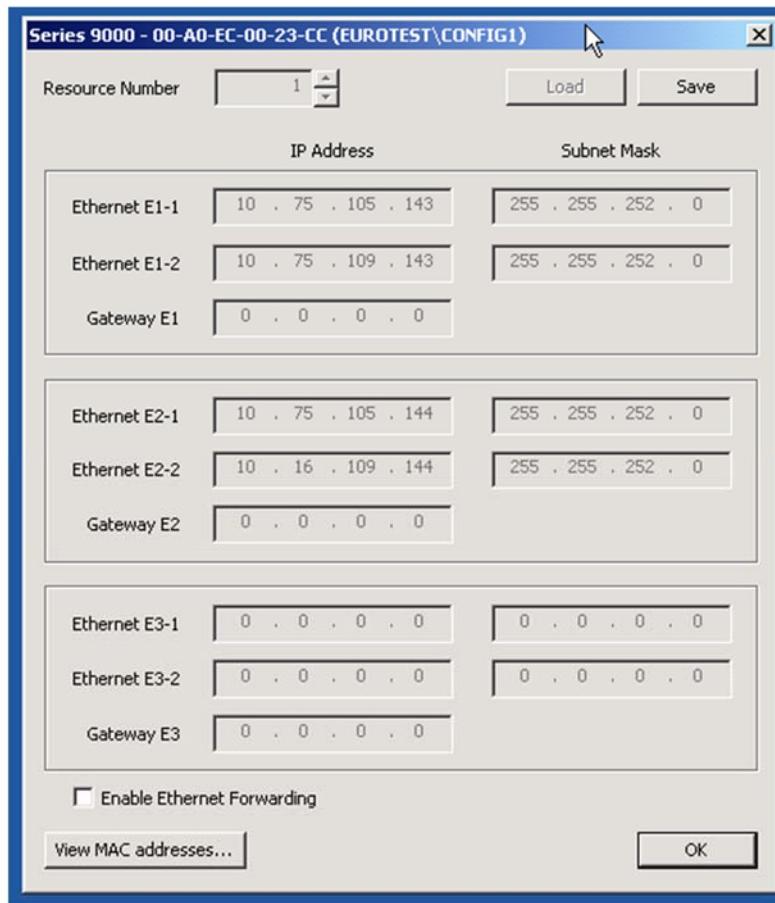
IMPORTANT The Resource Number must also be configured in the application in the Resource Properties.

Configure the IP Address in the Controller

When you assemble a new AAdvance controller, or install a new 9100 processor base unit, you have to configure the IP Address stored in the controller.

The procedure to configure the IP Address uses the AAdvance Discover utility. Changes occur immediately and you do not have to start the controller again. To set the IP Address do the following:

1. Write down the controller's MAC address (the Controller ID) displayed on a label on the processor base unit. Install at least one 9110 processor module into the processor base unit.
2. Make sure the program enable key is inserted in the KEY connector on the processor base unit.
3. Start the AAdvance Discover tool from the Start menu:
 - Start → All Programs → AAdvance → AAdvance Discover.
 - The AAdvance Discover utility scans the network for controllers, and creates a list.
 - It can also be launched from within the Workbench under the View menu.
4. Locate the controller in the list and make sure that the status of the controller is Configurable.
5. Double-click on the MAC address in the Controller ID field.
 - The resource and IP address dialog box is displayed.



1. Enter the IP Address and Subnet Mask into the fields for each Ethernet port.
2. Enter the Gateway values for each processor module, then click Apply.
 - Returning to the main window of the utility, the controller status will show In Progress and then Configurable.
 - The controller uses the new settings.

Page intentionally left blank.

Functional Acceptance Testing

Functional acceptance testing, also known as factory acceptance testing or integration testing, tests the controller and its application software to make sure that it satisfies the requirements specified in the requirements for the integrated system. If the controller is applied to a safety related application then the safety requirements are also tested.

Devising tests for Functional Acceptance

The tests performed during functional acceptance testing must include the following:

- Performance tests, including timing, reliability and availability, integrity, and safety requirements and constraints.
- Interface testing.

Write down the test cases and define the pass criteria for every test. Make sure that the test cases allow for the associated systems and their interfaces which the system needs to communicate with.

If a requirement cannot be physically demonstrated, devise a written analysis to show how the system achieves the requirement.

The AADvance controller has been tested to the limits given in its module specifications. If appropriate, do the following:

- Environmental tests, including electromagnetic compatibility, life- and stress-testing.
- Testing in degraded modes and fault modes.
- Exception testing.

Test Environment for Functional Acceptance

It is recommended that the testing is done in a factory environment, before installing and commissioning at the plant.

Managing Functional Acceptance Testing

Define the person or authority which will be responsible for doing each test and also the person or authority (such as the customer or their representative) who will witness each test.

Testing must be done on a known version of the controller. Record the type, serial number and physical location of each module so that the system can be dismantled, shipped and built with the modules in the same locations.

Review and finalize the technical manuals which have been prepared for the maintenance and operation of the system.

Dismantling the AADvance System

About Dismantling a System **Dismantling**

Dismantling is the opposite of the system assembly procedure.

Disposal

It is necessary to make a plan for the collection, treatment, recovery and environmentally sound disposal of the equipment at the end of its life. Contact Rockwell Automation to discuss the applicable way to do this.

Re-use

Before disposing of serviceable items, contact Rockwell Automation and find out if it is possible to return unwanted items for possible future reconditioning.

Page intentionally left blank.

Parts List

Base Units

Part No.	Part Description
T9100	Processor base unit
T9300	I/O base unit (3 way)

Modules

Part No.	Part Description
T9110	Processor module
T9401	Digital input module, 24 Vdc, 8 channel, isolated
T9402	Digital input module, 24 Vdc, 16 channel, isolated
T9451	Digital output module, 24 Vdc, 8 channel, isolated, commoned
T9431	Analogue input module, 8 channel, isolated
T9432	Analogue input module, 16 channel, isolated
T9481	Analogue output module, 3 channel, isolated
T9482	Analogue output module, 8 channel, isolated

Special Application Modules

Part No.	Part Description
T9441	Frequency Input Module (Product not yet released. Contact Sales for more information)

Termination Assemblies

Part No.	Part Description
T9801	Digital input TA, 16 channel, simplex, commoned
T9802	Digital input TA, 16 channel, dual
T9803	Digital input TA, 16 channel, TMR
T9831	Analogue input TA, 16 channel, simplex, commoned
T9832	Analogue input TA, 16 channel, dual
T9833	Analogue input TA, 16 channel, TMR

T9851	Digital output TA, 24Vdc, 8 channel, simplex, commoned
T9852	Digital output TA, 24Vdc, 8 channel, dual
T9881	Analogue output TA, 8 channel, simplex commoned
T9882	Analogue output TA, 8 channel, dual
T9844	Frequency Input Module TA, Simplex, Active (not yet released)
T9845	Frequency Input Module TA, Dual, Active (not yet released)
T9846	Frequency Input Module TA, TMR, Active (not yet released)
T9847	Frequency Input Module TA, Simplex, Passive (not yet released)
T9848	Frequency Input Module TA, Dual, Passive (not yet released)
T9849	Frequency Input Module TA, TMR, Passive (not yet released)

Expansion Cable Assembly

Expansion cable assembly, comprising expansion cable and two adapters

Part No.	Part Description
T9310-02	Backplane expansion cable, 2 metre

Blanking Covers

Part No.	Part Description
T9191	Blanking cover (tall) for I/O positions with no TA fitted
T9193	Blanking cover (short) for I/O positions with TA or a Processor

Spares & Tools

Part No.	Part Description
T9901	Replacement input fuse 50 mA for T9801/2/3 and T9831/2/3, pack of 20 ¹
T9902	Replacement output fuse 10A for T9851/2, pack of 20 ²
T9903	Replacement coding pegs (pack of 20)
T9904	Replacement backplane clips (pack of 20)
T9905	Replacement processor 3 V lithium cell, pack of 20 ³
T9906	Replacement program enable key
T9907	Installation tool kit
T9908	Fuse Extractor Tool

Software

Part No.	Part Description

T9082U	IEC 61131 Workbench, USB key, single user, single controller
T9082D	IEC 61131 Workbench, hard disk key, single user, single controller
Part No.	Part Description
T9083U	IEC 61131 Workbench, USB key, multiple controllers
T9083D	IEC 61131 Workbench, hard disk key, multiple controllers
Part No.	Part Description
T9084U	IEC 61131 Workbench, 5 user USB key, multiple controllers
T9085	5 additional user licences, for use with T9084U
T9087	IEC 61131 Workbench 2
Part No.	Part Description
T9030	OPC portal server
T9033	AADVANCE DTM (for use with HART Pass-Through feature)
Demonstration Unit	
Part No.	Part Description
T9141	AADVANCE Demonstration Unit (Including HMI)
Miscellaneous Items	
Part No.	Part Description

¹ T9901: No 396/TE5 50 mA time lag fuse; UL 248-14, 125 V, Leadfree; manufactured by Littelfuse.

² T9902: SMF Omni-Block, Surface Mount Fuse Block 154 010, with a 10 A, 125 V Fast Acting Fuse, Littelfuse.

³ T9905: Polycarbon monofluoride Lithium Coin Battery, BR2032, 20 mm dia; Nominal voltage 3 V; Nominal capacity (mAh) 190; Continuous standard load (mA) 0.03; Operating temperature -30 °C to +80 °C, supplied by Panasonic.

Page intentionally left blank.

9000 Series Glossary

Glossary of Terms

A

accuracy

The amount of closeness of a measurement of a quantity to the true value of the quantity. See also 'resolution'.

achievable safe state

A safe state that is achievable.

Sometimes, a safe state cannot be achieved. An example is a non-recoverable fault such as a voting element with a shorted switch and no means to bypass the effect of the short.

actuator

A device causing an electrical, mechanical, or pneumatic action to occur in a plant component. Examples are valves and pumps.

AITA

Analogue input termination assembly.

alarms and events (AE)

An OPC data type providing time-stamped alarm and event notifications.

allotted process safety time

The part of the total process safety time allotted to a sub function of a process.

application software

Software written specially for a user application, typically using logic sequences, limits and expressions to read inputs, make decisions and control outputs for a specified system.

architecture

Organizational structure of a computing system describing the functional relationship between board level, device level and system level components.

asynchronous

A data communications term describing a serial transmission protocol. A start signal is sent before each byte or character and a stop signal is sent after each byte or character. An example is ASCII over RS-232-C. See also 'RS-232-C, RS-422, RS-485'.

availability

The probability that a system can do its specified functions when required for use. Normally expressed as a percentage.

B

backplane clip

A sprung, plastic device to holding together two adjacent AAdvance base units. Part number 9904. Used in pairs.

base unit

One of two designs making the supporting parts of an AAdvance controller. See 'I/O base unit' and 'processor base unit'.

binding

A relationship between two variables in different AAdvance controllers. One variable is a producer and the other is a consumer. The system updates the value in the consumer to match the data in the producer. See 'SNCP protocol'.

black channel

A path for communications data which does not maintain the integrity of the data transferred over it. Measures to find and compensate for errors introduced by the black channel are implemented by software or hardware (or both) in the safety critical sender and receiver.

blanking cover

A plastic moulding to hide an empty slot in an AAdvance controller base unit.

Boolean

A type of variable that can only accept only the values 'true' and 'false'.

BPCS

Basic process control system. A system responding to input signals and generating output signals causing a process and its related equipment to operate in a desired way, having no safety instrumented functions with a safety integrity level of 1 or higher. See IEC 61511 and ANSI/ISA—84.00.01—2004 Part 1 (IEC 61511-1 Mod) for a formal definition. Equivalent to the Process Control System (PCS) specified by IEC 61508.

breakdown voltage

The maximum voltage (AC or DC) that can be continuously applied between isolated circuits without failure of the insulation.

BS EN 54

A standard for fire detection and fire alarm systems.

BS EN 60204

A standard for the electrical equipment of machines, which promotes the safety of persons and property, consistency of control response and to make maintenance easy.

bus

A group of conductors for related data. Typically allocated to address, data and control functions in a microprocessor-based system.

bus arbitration

A mechanism for deciding which device has control of a bus.

C**CIP**

Common Industrial Protocol. A communications protocol created by Rockwell Automation for the Logix controller family, and supported by the AADvance controller. AADvance controllers use the protocol to send data to and from Logix controllers using a consumer/producer model. It can also be used to communicate data between AADvance controllers.

clearance

The shortest distance in air between two conductive parts.

coding peg

A polarizing key, fitted to the 9100 processor base unit and to each termination assembly ensuring that only a module having the correct type can be fitted in a slot. Part number 9903.

coil

In IEC 61131-3, a graphical component of a Ladder Diagram program representing the assignment of an output variable. In Modbus language, a discrete output value.

Compiler Verification Tool (CVT)

A software utility that validating a compiled application to look for errors introduced by the Workbench or the compiler. Frequently abbreviated to CVT.

configuration

A grouping of the application software and settings for a specified AADvance controller. The grouping must have a 'target', but for an AADvance controller it can have only one 'resource'.

consumer

The consuming controller requests the tag from the producing controller.

contact

A graphical component of a Ladder Diagram program representing the status of an input variable.

continuous mode

Where the Safety Instrumented Function in the safety system is continually maintaining the process in a safe condition.

controller

A logic solver. The combination of application execution engine and I/O hardware.

controller system

One or more controllers, their power sources, communications networks and workstations.

coverage

The percentage of faults that are detected by automated diagnostics. See also 'SFF'.

creepage distance

The shortest distance along the surface of an insulating material between two conductive parts.

cross reference

Information calculated by the AADvance Workbench relating to the dictionary of variables and where those variables are used in a project.

D

data access (DA)

An OPC data type providing real-time data from AADvance controllers to OPC clients.

de-energize to action

An output circuit for a safety instrumented function where the field device is usually energized. Removal of power de-activates the device.

dictionary

The set of internal input and output variables and defined words used in a program.

discrepancy

A condition that exists if one or more elements disagree.

DITA

Digital input termination assembly.

DOTA

Digital output termination assembly.

E

element

A set of input conditioning, application processing and output conditioning.

energize to action

An output circuit for a safety instrumented function where the devices are usually de-energized. Application of power activates the field device.

EUC

Equipment under control. The machinery, apparatus or plant used for manufacturing, processing, transportation, medical or other activities.

expansion cable assembly

A flexible interconnection carrying bus signals and power supplies between AADvance base units, available in a variety of lengths. Used with a cable socket assembly (at the left side of a base unit) and a cable plug assembly (at the right side of a base unit).

F

fail operational state

A condition where a fault has been masked. See 'fault tolerant'.

fail safe

The ability to go to a pre-determined safe condition when a specified malfunction occurs.

fault reset button

The momentary action push switch on the front panel of the 9110 processor module.

fault tolerance

The ability of a system to operate correctly with a specified number of hardware and software faults.

fault tolerant

The ability of a system to accept the effect of one arbitrary fault and continue correct operation.

fault warning receiving station

A location where corrective measures can be initiated.

fault warning routing equipment

Equipment which routes a fault warning signal from control and indicating equipment to a fault warning receiving station.

field device

An item of equipment connected to the field side of the I/O terminals. Such equipment includes field wiring, sensors, final control elements and operator interface devices which are hard-wired to I/O terminals.

fire alarm device

A component of a fire alarm system, not incorporated in the control and indicating equipment which is used to give a warning of fire — for example a sounder or visual indicator.

fire alarm receiving station

A location from which fire protection or firefighting measures can be initiated.

fire alarm routing equipment

Equipment which routes an alarm signal from control and indicating equipment to a fire alarm receiving station.

function block diagram

An IEC 61131 language describing a function between input variables and output variables. Input and output variables are connected to blocks by connection lines. See 'limited variability language'.

functional safety

The ability of a system to perform the actions necessary to achieve or to maintain a safe state for a procedure and its related equipment.

group

A collection of two or three input modules (or two output modules), arranged together to supply enhanced availability for their input or output channels.

H***hand-held equipment***

Equipment which is intended to be held in one hand while being operated with the other hand. See 'portable equipment'.

HART

Highway Addressable Remote Transducer. An open protocol for process control instrumentation. It combines digital signals with analogue signals to give control and status data for field devices. For more details about HART devices refer to the HART Application Guide, created by the HART Communication Foundation, and the full HART specifications. You can download documents from www.hartcomm.org.

high demand mode

Where the Safety Instrumented Function in the safety system only performs its designed task on a demand, and the frequency of demands is more than one time each year.

hot swap

See live insertion.

G

I

I/O base unit

A backplane assembly holding one, two, or three I/O modules and their related termination assembly or assemblies in an AADvance controller. Part number 9300. See 'I/O module' and 'termination assembly'.

I/O module

An AADvance module continuing interfaces for inputs from field sensors and generating output for field elements. Connects to the field through Termination Assemblies and to the processor across I/O bus connections.

IEC 61000

A series of international standards providing techniques for testing and measuring electromagnetic compatibility.

IEC 61131

An international standard defining programming languages, electrical parameters and environmental conditions for programmable logic controllers. Part 3, which is entitled 'Programming Languages', defines more than one limited variability language.

IEC 61499

An international standard defining an open architecture for distributed control and automation.

IEC 61508

An international standard for functional safety, encompassing electrical, electronic and programmable electronic systems; hardware and software aspects.

IEC 61511

An international standard for functional safety and safety instrumented systems for the process industry, encompassing electrical, electronic and programmable electronic systems, hardware and software aspects.

indicator

A device whose state can change to provide data.

input (AADvance Workbench variable)

In the context of an AADvance Workbench variable, a quantity passed to the Workbench from a controller.

instruction list

An IEC 61131 language, almost the same as the simple textual language of PLCs. See 'limited variability language'.

integer

A variable type specified by the IEC 61131 standard.

K

key connector

The receptacle on the AADvance controller for the program enable key. A 9-way 'D' type socket on the 9100 processor base unit.

L***ladder diagram***

An IEC 61131 language composed of contact symbols representing logical equations and actions. The main function is to control outputs based on input conditions. See 'limited variability language'.

LAN

Local area network. A computer network covering a small physical area, characterized by a small geographic range having no need for leased telecommunication lines.

live insertion

The removal and then reinsertion of an electronic module into a system while the system remains powered. The assumption is that removal of the module and reinsertion will cause no electrical harm to the system. Also known as 'hot swap'.

low demand mode

Where the Safety Instrumented Function only performs its designed task on demand, and the frequency of demands is no more than one time each year.

M***manual call point***

A component of a fire detection and fire alarm system enabling a person to trigger an alarm.

Modbus

An industry standard communications protocol developed by Modicon. Used to communicate with external devices such as distributed control systems or operator interfaces.

Modbus object

A representation of the configuration settings for a Modbus master or for its related slave links, in the AADvance Workbench. The settings include communication settings and messages.

module clamp screw

The AADvance latch mechanism seen on the front panel of each module and operated by a broad, flat-blade screwdriver. Uses a cam action to hold the module to its base unit.

N***NFPA 85***

The Boiler and Combustion Systems Hazards Code. Applies to some boilers, stokers, fuel systems, and steam generators. The code helps to prevent uncontrolled fires, explosions and implosions.

NFPA 86

A standard for ovens and furnaces. Provides the requirements for the prevention of fire and explosion hazards related to heat processing of materials in ovens, furnaces and related equipment.

0***on-line***

The condition of a controller that executes the application software.

OPC

A series of standards specifications for open connectivity in industrial automation.

output (Workbench variable)

In the context of an AADvance Workbench variable, this term describes a quantity passed from the Workbench to a controller.

P

peer to peer (network)

One or more Ethernet networks connecting together a series of AADvance or Trusted controllers enabling application data to pass between them.

pinging

In Modbus communications, sending the diagnostic Query Data command over a link and by receiving a reply to ensure that the link is healthy and the slave can communicate with the master. No process data is transferred or modified.

portable equipment

Enclosed equipment that is moved while in operation or which can easily be moved from one location to a different location while connected to the power supply. Examples are programming and debugging tools and test equipment. See 'hand held' equipment.

processor base unit

A backplane assembly holding all of the processor modules in an AADvance controller. Part number 9100. See also 'processor module'.

processor module

The application execution engine of the AADvance controller, housed in a self-contained and standardized physical enclosure.

producer

A controller producing a tag to one or more consumers. The controller produces a tag when a consumer asks for one.

program enable key

A security device that permitting access to the application in an AADvance controller. Part number 9906. Supplied with the processor base unit. See also 'key connector'.

project

A collection of configurations and the definition of the linking between them. See 'configuration'.

proof test

A test performed at a predetermined frequency which functionally tests all of the components making up a Safety Instrumented Function, designed specifically to show any undetected failures so that these can be repaired to make sure that the Safety Instrumented Function continues to satisfy its designed performance criteria over the safety life cycle.

protocol

A set of rules that is used by devices (such as AADvance controllers, serial devices and engineering workstations) to communicate with each other. The rules encompass electrical parameters, data representation, signaling, authentication, and error detection. Examples include Modbus, TCP and IP.

PST

Process Safety Time. The process safety time for the equipment under control (denoted PST_{EUC}) is the length of time a dangerous condition can exist before a hazardous event occurs without a safety system as a protection.

R***real***

A class of analogue variable stored in a floating, single-precision 32-bit format.

redundancy

The use of two or more devices, each performing the same function, to increase reliability or availability better.

resolution

The smallest value measurable by an instrument; the level of detail which can be represented. For example, 12 bits can distinguish between 4096 values.

RS-422, RS-485

Standard interfaces introduced by the Electronic Industries Alliance covering the electrical connection between data communication equipment.

RTC

Real-time clock.

RTU

Remote terminal unit. The Modbus protocol supported by the AADvance controller for Modbus communications over serial links, with the ability to multi-drop to multiple slave devices.

S***safe state***

A condition which permitting the execution of a process demand. Usually entered after the detection of a fault condition, ensuring that the effect of the fault is to enable rather than disable a process demand.

safety accuracy

The accuracy of an analogue signal in which the signal is guaranteed to have no dangerous faults. If the signal drifts outside this range, it is declared faulty.

safety-critical state

A faulted condition preventing the execution of a process demand.

sensor

A device (or a combination of devices) that measures a process condition. Examples are transmitters, transducers, process switches and position switches.

sequential function chart

An IEC 61131 language dividing the process cycle into a number of specified steps separated by transitions. See 'limited variability language'.

SFF

Safe Failure Fraction. Given by (the total rate of safe failures plus the rate of detected dangerous failures) divided by (the total rate of safe failures plus the rate of detected and undetected dangerous failures).

SIF

Safety Instrumented Function. A type of process control performing specified functions to get (or maintain) a safe state of a process when unacceptable or dangerous process conditions are detected.

SIL

Safety Integrity Level. One of four possible levels, specified in IEC 61508 and IEC 61511, for specifying the performance requirements of the safety functions allocated to a safety-related system. SIL4 has the highest level of safety integrity, SIL1 has the lowest. For an installation to get a specified SIL rating, all of the parts of the installation (together with the AADvance controller) must fulfill these requirements.

SNCP

Safety Network Control Protocol. A set of rules that allowing different AADvance controllers in a system to share data. SNCP is a SIL 3 certified protocol which provides a safety layer for an Ethernet network.

SNTP

Simple Network Time Protocol. A set of rules for synchronizing the real-time clocks of AADvance controllers and other devices over Ethernet networks.

structured text

A high level IEC 61131-3 language with syntax equivalent to that of Pascal. Useful for making complex procedures that cannot be expressed easily with graphical languages.

synchronous

A data communications term describing a serial transmission protocol. A pre-arranged number of bits is expected to be sent across a line each second. To synchronize the sending and receiving machines, a clocking signal is sent by the transmitting computer. There are no start or stop bits.

T

TA

See 'termination assembly'.

target

An attribute of a 'configuration' which describes characteristics of the AADvance controller on which the configuration will run. Includes characteristics such as the memory model and the sizes of variable types for the controller.

TCP

Transmission control protocol. A set of rules used by applications requiring guaranteed delivery of a stream of bytes from a program found on one computer to a different program, typically found on a different computer. An example for an AADvance controller is Modbus communications over Ethernet. One of the core protocols of the Internet Protocol suite.

termination assembly

A printed circuit board connecting field wiring to an input or output module. The circuit includes fuses for field circuits. The board carries screw terminals to connect the field wiring to the controller, and the whole assembly clips onto the 9300 I/O base unit.

TMR

Triple modular redundant. A fault-tolerant arrangement in which three systems complete a process and their result is processed by a voting system to provide one output.

TÜV certification

Independent third-party certification against a range of international standards including IEC 61508.

U

U

Rack unit. A unit of measure used to give the height of equipment intended for mounting in a standard rack. Equivalent to 44.45 mm (1-¾ inches).

V***validation***

In quality assurance, approval that the product does what the user requires.

verification

In quality assurance, approval that the product conforms to the specifications.

voting system

A redundant system (m out of n) requiring at least m of the n channels to be in agreement before the system can take action.

W***withstand voltage***

The maximum voltage level that can be applied between circuits or components without causing a failure of the insulation.

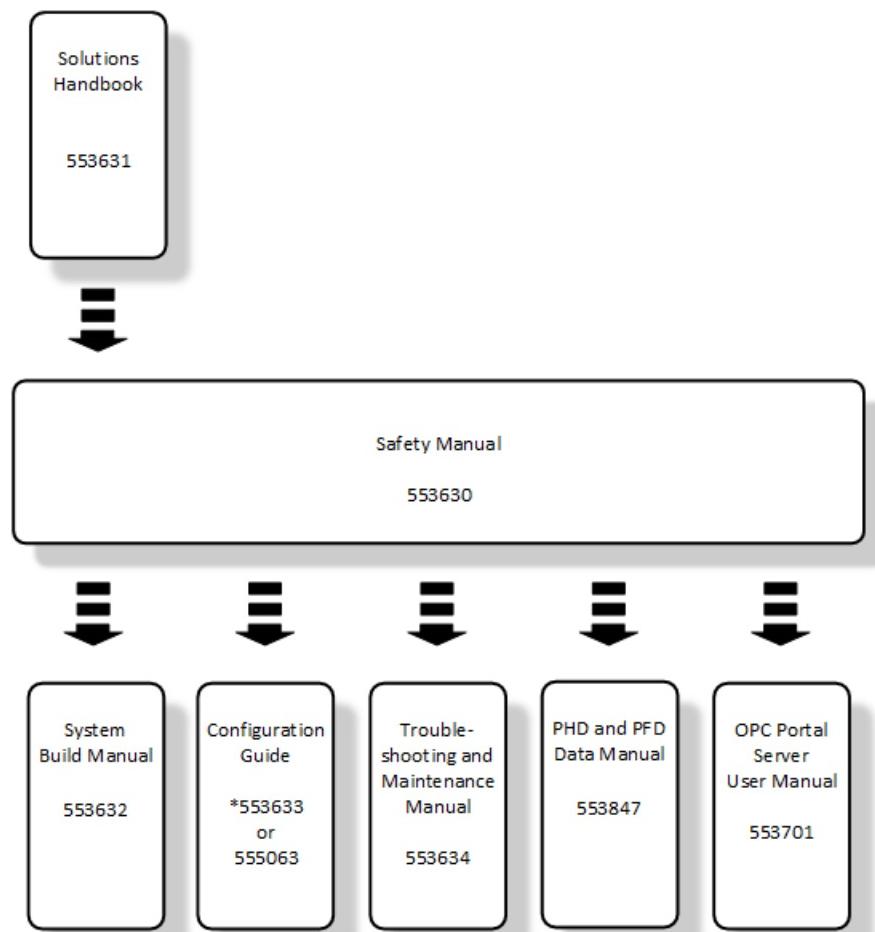
word

A 16-bit unsigned value from 0 to 65535. One of the IEC 61131 types. See also 'integer'.

Page intentionally left blank.

Additional Resources

For more information about the AAdvance system refer to the related Rockwell Automation technical manuals shown in this document map.



* Actual configuration guide applicable is dependent upon version of AAdvance Workbench used.

Publication	Purpose and Scope
Safety Manual	This technical manual defines how to safely apply AADvance controllers for a Safety Instrumented Function. It sets out standards (which are mandatory) and makes recommendations to make sure that installations satisfy and maintain their required safety integrity level.
Solutions Handbook	This technical manual describes the features, performance and functionality of the AADvance controller and systems. It gives guidance on how to design a system to satisfy your application requirements.
System Build Manual	This technical manual describes how to assemble a system, switch on and validate the operation of your system.
Configuration Guide	This software technical manual defines how to configure an AADvance controller using the AADvance Workbench to satisfy your system operation and application requirements.
Troubleshooting and Maintenance Manual	This technical manual describes how to maintain, troubleshoot and repair an AADvance Controller.
OPC Portal Server User Manual	This manual describes how to install, configure and use the OPC Server for an AADvance Controller.
PFH and PFDavg Data	This document contains the PFH and PFD _{avg} Data for the AADvance Controller. It includes examples on how to calculate the final figures for different controller configurations.

Regional Offices

Rockwell Automation 4325 West Sam Houston Parkway North, Suite 100 Houston Texas 77043-1219 USA	Rockwell Automation Hall Road Maldon Essex CM9 4LA England	Rockwell Automation Millennium House Campus 1 Aberdeen Science & Technology Park Balgownie Road, Bridge of Don Scotland
Tel: +1 713 353 2400 Fax: +1 713 353 2401	Tel: +44 1621 854444 Fax: +44 1621 851531	Tel: +44 1224 227780

Rockwell Automation No. 2 Corporation Road #04-01 to 03 Corporation Place Singapore 618494	ICS Middle East LLC Al Wahda Office Tower Office Numbers 1801/ 1802/ 1803/ 1804 Haza Bin Zayed Street (11th Street) PO Box 45235 Abu Dhabi UAE	Silvertech Middle East FZCO PO Box 17910 Jebel Ali Free Zone Dubai, UAE
Tel: +65 6622 4888 Fax: +65 6622 4884	Tel: +971 2 694 8100	Tel: +971 4 883 7070